Electronic Engineering

PARMEKO

* PARMEKO factories and research laboratories combine over thirty years of production experience with the latest technical advances to bring you the internationally known Parmeko range of transformers, transductors, and magnetic amplifiers. Their unparalleled quality and high precision enable the world's largest electronic equipment manufacturers to specify Parmeko products with confidence. You could well follow their example.

HEAD OFFICE AND MAIN WORKS

WIGSTON PRODUCTION FACTORY

RESEARCH LABORATORY

PARMEKO LTD · PERCY ROAD · LEICESTER · ENGLAND
Telephone Leicester 32207, Telegrams Parmeko Leicester

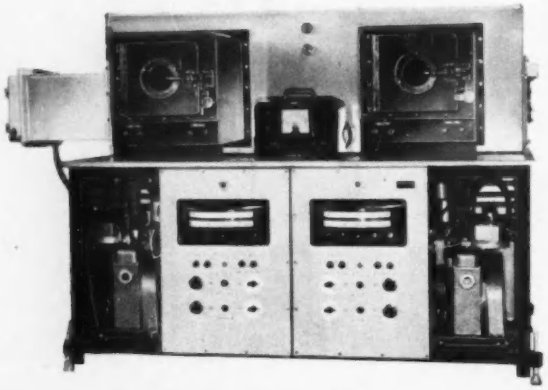
EE 30 002 *for further details*

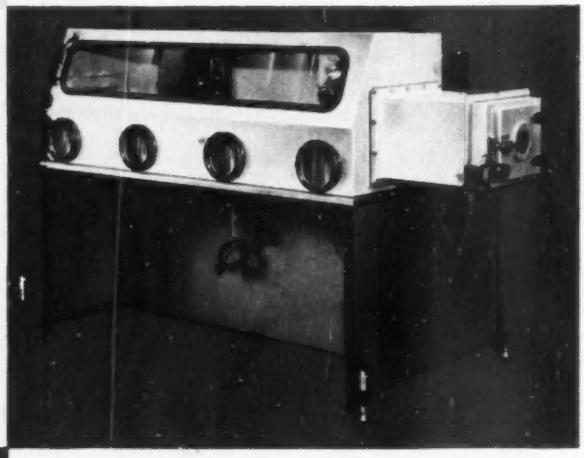
DOUBLE ENDED STAINLESS STEEL VACUUM OVENS

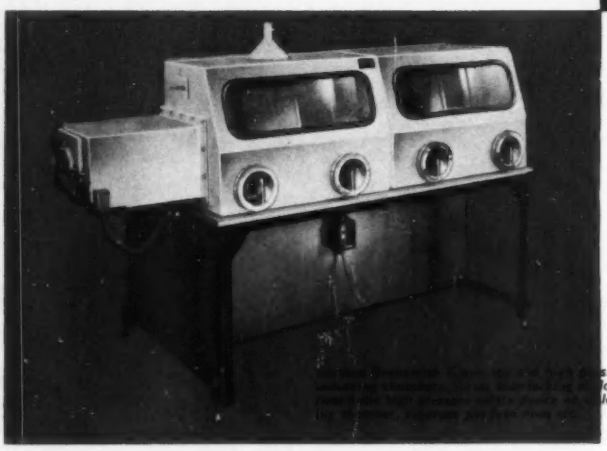
with glove box for semiconductor devices

We design and manufacture Ovens to Customer's special requirements. Should you have any problems in this field our Technical Department is always willing to help you solve them. Vacuum Ovens with temperatures of up to 600°C are also manufactured by us on similar lines but with Sectional Heating and Water-Cooled Ends.

We design, manufacture and supply Vacuum Machinery to major companies in Great Britain and Overseas.







ssure
oors.
load-

Made throughout in polished stainless steel.
Single action door openings.
Rectangular with self spacings to suit.
Double-ended controls.
Electrical interlocking of air inlet and isolation valve.
Outer cover hermetically sealed.
Temperature Range 0-400 C.
or equivalent F.

Temperature Control: Normal ±7½°C. Special ±1°C.
Internal Spacing 7" x 8" x 18".
(can be altered to special requirements).
Vacuum Range: To 10^{-4} m.m.
Respective Vacuum Gauges incorporated.
Automatic air inlet valve on Backing Pump.
Visual Indicators and Fuses on all switches.
Flanged for fitting into Dry Box.

VACWELL ENGINEERING CO., LTD.

WILLOW LANE · MITCHAM · SURREY Tel: MITcham 8211 (3 lines)

VACWELL ENG. CO. LTD.

Vol. 33 No. 396

FEBRUARY 1961

Electronic Engineering

Incorporating ELECTRONICS, TELEVISION and SHORT WAVE WORLD

Managing Editor: H. G. FOSTER, *M.Sc., M.I.E.E., M.Brit.I.R.E.*

CONTENTS

	Commentary	67
	Electroluminescence—Its Characteristics and Applications (Part 1) *by D. H. Smith*	68
	Capacitor Impulse Generators *by E. R. Wooding*	73
	Analogue Telemetry Equipment and Systems (Part 2) *by S. Poole, A. Potton and C. O. Titley*	77
	An X-ray Spectrometer for Space Research	83
	Selective RC Amplifier Using Transistors *by R. Hutchins*	84
	Alloy-Diffused Transistors *by E. Wolfendale*	88
	Speed Control for Television Camera Attitude	93
	Fluidized Beds as Constant Temperature Enclosures *by H. Suteliffe*	94
	A Multi-Purpose Computer Element *by C. B. Taylor*	96
	Artificial Stimulation of the Heart	99
	A Variable Bandwidth Band-pass Filter *by J. Holland*	100
	A Transfer Function Computer	105
	A Quick Method for the Design of Butterworth Filters *by J. S. Bell and P. G. Wright*	106
	Short News Items	109
	Book Reviews	112
	Electronic Equipment	116
	Meetings this Month	122
	Publications Received	122
FRANÇAIS	**Équipement Électronique**	123
	Résumés des Principaux Articles	128
DEUTSCH	**Elektronische Geräte**	130
	Zusammenfassung der wichtigsten Beiträge	135

CLASSIFIED ADVERTISEMENTS page 207 **INDEX TO ADVERTISERS page 221**

PUBLISHED MONTHLY on the last Friday of the preceding month by:

MORGAN BROTHERS (PUBLISHERS) LIMITED
at 28, Essex Street, Strand, London, W.C.2.
Telephone: CENtral 6565 Telegrams: 'Lectroning, Estrand, London'
Annual Subscription: Home and Overseas £1.16.0 post free, Canada and U.S.A. $5.

EE 30 005 *for further details*

LATEST IN A FAMOUS LINE

THREE YEARS AGO we offered the first SERVISCOPE* to industry with notable success. Last year we introduced a double beam version and again acceptance was immediate. Now we extend the range still further with the new S.42, a high performance version of the original Serviscope with many outstanding features.

- 4" spiral P.D.A. C.R. tube operating at 3.7 Kv.
- Increase gain—maximum sensitivity 10 mV.
- Unique extendible light hood.
- Pulse bright-up for single stroke working.
- H.F. synchronisation compatible with Y amplifier performance.

Accurate calibrated input attenuator. Wide range calibrated time base (down to 5 sec/cm. if necessary). X expansion control to 10 dia. D.C. coupled flyback banking. Versatile triggering circuit unique to 'Serviscopes'. Illuminated graticule. Weight: 18 lbs. Price: £92.

Basically the same rugged, lightweight, versatile instrument as its well-tried predecessors, the S.42 has the ability to meet more exacting demands with its high writing speed and additional high gain facility. Evolved originally for computer development and servicing, the S.42 has special applications wherever pulses have to be measured at low repetition rates, for example, a single shot 1μ sec. pulse can be seen and photographed. In addition, it has general applications throughout the electronics industry.

TELEQUIPMENT

** 'Serviscope' is the registered trade mark of* **TELEQUIPMENT LIMITED** 313 Chase Road, Southgate, London, N.14. *Telephone: Fox Lane 1166*

THE TREND TOWARDS MINIATURISATION

To meet the increasing demand for miniaturisation combined with accuracy, we are producing highly stable precision wirewound resistors of minute dimensions to standard specification. Please write for further details.

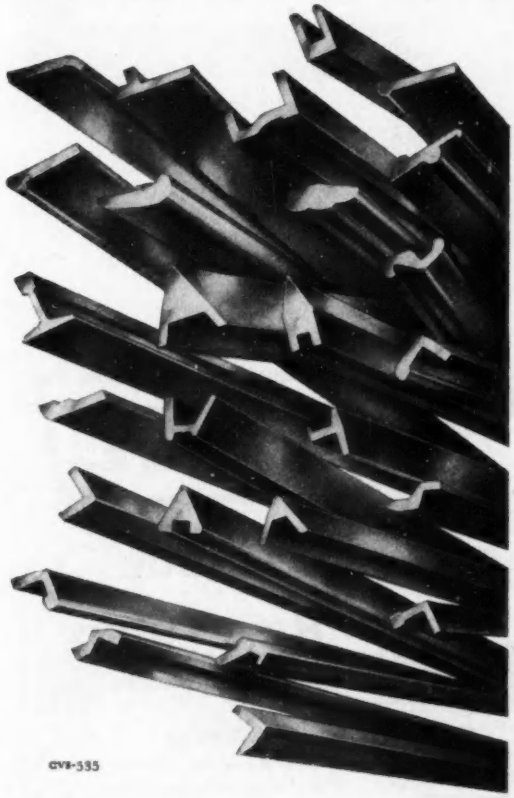
- DIMENSIONS $\frac{1}{8}$" long by $\frac{3}{32}$" diameter. Axial eadouts 20 s.w.g. tinned copper wire $2\frac{1}{4}$" long.
- Standard Tolerances set at 20°C.: 1%, 0·5%, 0·25% and 0·1%.
- ANY VALUE can be supplied in the Resistance Range 100 ohms to 500K ohms.
- Rating $\frac{1}{2}$ watt.
- Guaranteed Temperature Coefficient better than 0.002% per °C. over the whole resistance range.
- Specially selected wire is sealed against humidity in a resin which can withstand temperatures of over 150°C.
- Precision Component designed and manufactured for consistent accuracy.

Standard products include 2W, 1W, 1/2W and 1/4W precision wirewound resistors in the range 0.1 ohms to 10 megohms. Higher values can also be produced to order.

Alma **COMPONENTS LTD.**

PARK ROAD, DISS, NORFOLK. Telephone : DISS 2288.

551, HOLLOWAY ROAD, LONDON, N.19 Telephone: ARCHWAY 0014/5



GV3-535

BOLTON'S

H. C. COPPER

EXTRUDED AND DRAWN SECTIONS

All shapes for electrical and other purposes

BOLTON'S PRODUCTS include copper and copper-base alloys in the form of wire and strand, bar and rod, sheet, strip and foil, busbars, commutator, segments and tubes.

THOMAS BOLTON & SONS LTD

THOMAS BOLTON & SONS LTD

Head Office: Mersey Copper Works, Widnes, Lancashire
Telephone: Widnes 2022

London Office & Export Sales Dept: 168 Regent St., W.1.
Telephone: REGent 6427

EE 30 007 *for further details*

Two 5-inch high quality instrument tubes

These two instrument tubes are being produced by ETEL to fulfil the requirements of a variety of applications where a 5-inch tube is needed.
Both the 5BUP31 and 5BVP31A are high quality p.d.a. tubes with flat screens and side plate connections. Their range of operating voltages is wide and is an important feature of their versatility. The screen of the 5BVP31A is aluminized, and the higher operating voltages allowed with this tube suit it for recording faster phenomena.
Full data is available upon request to the address below.

Abridged Data

Heater
Vh=6.3V Ih=0.55A

Capacitances
Cx'—x'' 1.6pF
Cy'—y'' 1.5pF
One X plate to all other electrodes less other X plate—3.0pF
One Y plate to all other electrodes less other Y plate—2.7pF

Typical Operation

	5BUP31	5BVP31A
Va1	2.0kV	1.5kV
Va2 ... ... (for focus)	500V approx.	1.0kV approx.
Va3	2.0kV	4.0kV
Va4	4.0kV	8.0kV
Vg	-28 to -62V	-43 to -92V
Sx	29V/cm	57V/cm
Sy	17.5V/cm	35V/cm

(The green medium persistence phosphor used by E.T.L. has now been designated P31. It is exactly the same as the E.T.L. phosphor previously called P1.)

ETEL

Cathode Ray Tubes

ELECTRONIC TUBES LIMITED
Kingsmead Works
High Wycombe · Bucks
Tel: High Wycombe 2020

ETL 22

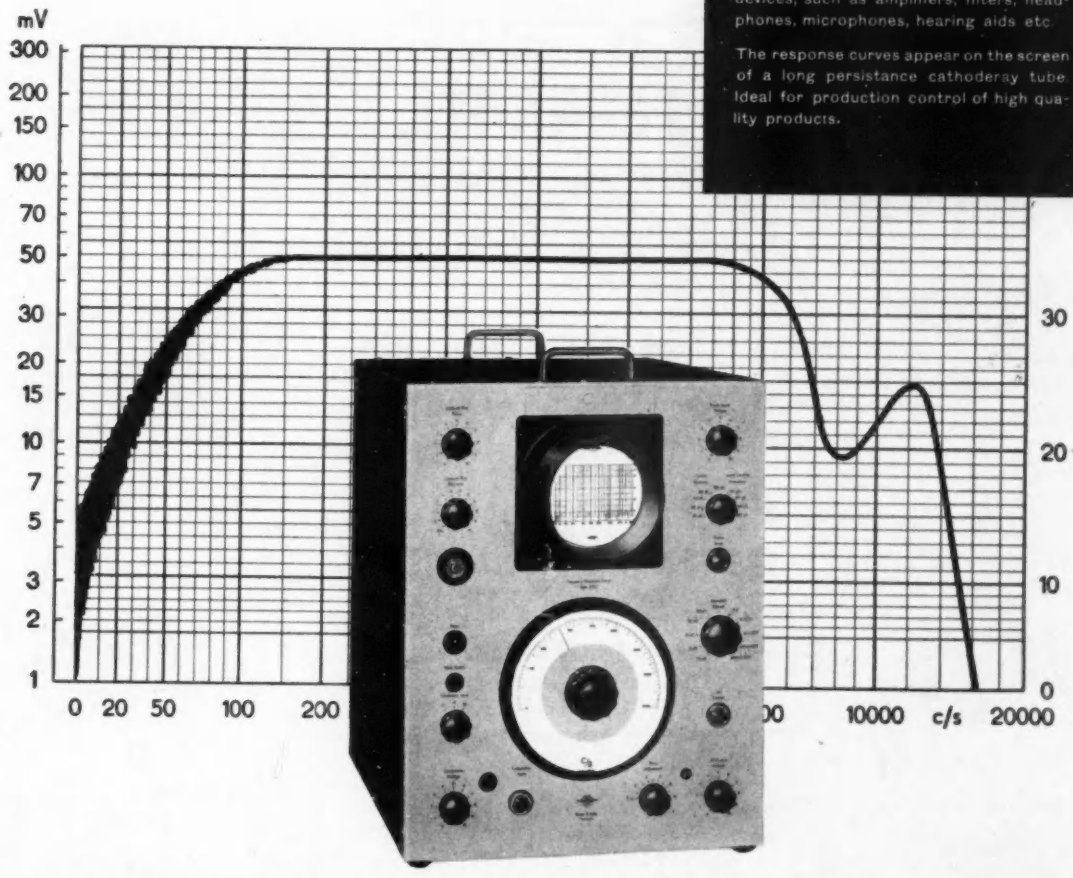
EE 30 009 *for further details*

PRODUCTION CONTROL

by VISUAL INSPECTION
of FREQUENCY CHARACTERISTICS

In less than 5 seconds the Frequency Response Tracer Type 4707 checks frequency characteristics of A. F. devices, such as amplifiers, filters, headphones, microphones, hearing aids etc.

The response curves appear on the screen of a long persistance cathoderay tube. Ideal for production control of high quality products.



Some technical data:
The Frequency Response Tracer consists of a beat frequency oscillator and regulating amplifier and a cathoderay oscilloscope. The X-deflection is synchronized with the motor-driven frequency sweep of the oscillator, sweeping the frequency range from 0-20000 c/s automatically.

Response of Y-deflection amplifier: 50 db logarithmic.
Frequency response of Regulating amplifier: ± 0,5 db from 50 to 20000 c/s.
Frequency response of oscilloscope section: ± 0,5 db from 50 to 20000 c/s.

B K **Brüel & Kjær**

Adr.: NÆRUM, DENMARK · Teleph.: NÆRUM 800500 · Cable: BRUKJA, COPENHAGEN
SALES AND SERVICE: B & K Laboratories, 4 TILNEY STREET, PARK LANE, W.1

FERRANTI

MICROWAVE FERRITE COMPONENTS FOR RADAR AND COMMUNICATIONS

Included in the range are :-

ISOLATORS

Peak Powers up to 2½ MW. at S-Band.

Peak Powers up to 200 KW. at X-Band.

3 & 4 PORT CIRCULATORS, SWITCHES AND MODULATORS

3 & 4 Port Circulators, Switches and Modulators, for S-Band and X-Band Applications.

Write for further details to :-

FERRANTI LTD · KING'S CROSS ROAD · DUNDEE · Telephone: DUNDEE 87141

DS/T70

EE 30 011 *for further details*

DRY FOR ALL CHANNELS

Birlec Adsorption Dryer at the AEI Heavy Plant Division, Rugby, drying compressed air for dry boxes in which are assembled germanium powder, semi-conductor, rectifier cells.

Moisture costs money as it slows down production and causes deterioration in quality of electronic components.

Birlec Direct Dehumidifiers—simple, reliable and economical—are already maintaining very low humidities for the manufacture of transistors, computors, radar sets, cathode ray tubes, etc.

BIRLEC

AEI-Birlec Limited

Tyburn Road · Erdington · Birmingham 24

Telephone: East 1544 *Telex No: 33471*

LONDON · SHEFFIELD · NEWCASTLE-ON-TYNE · GLASGOW · CARDIFF

SM/B6230

EE 30 012 *for further details*

G.E.C.

Environmental testing of small components and valves

Type VEM..5.2 Vibrator

Ideally suitable for use in the reliability assessment of electrical and electronic components, and for fatigue testing and resonance examination, this vibrator will operate continuously at peak alternating thrusts of ± 300 lb. wt., within a frequency range extending from 10 c/s to 10 kc/s. By using a rigid moving system with no vibrating electrical connections, fatigue in the machine is eliminated; also, the electrical impedance is constant over the operating frequency range.

The Company will be pleased to submit quotations for the supply of vibrators of the above type to meet your specific requirements

SPECIFICATION

Thrust	± 300 lb wt
Force Factor	33 lb/amp
Excursion (Peak)	± 1 inch
Frequency Range	20 c/s - 10 kc/s
Lower 'Table' Resonance	5 kc/s
Impedance	13 ohms at 1kc/s
Weight of Moving System	5 lbs
Input drive requirement	1.5 KVA
Input current	8.5 amps max input 20 c/s to 4 kc/s 8 amps max input 4 kc/s to 10 kc/s
Field Coil Supply	1.8 amps at 240 volts dc
Cooling	Forced Air (centrifugal blower)
Mounting	Vertical
Overall Height	15 inches
Diameter	17 inches

THE GENERAL ELECTRIC COMPANY LTD OF ENGLAND Electronics Division, Lower Ford Street, Coventry

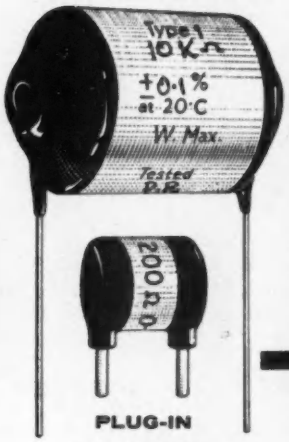
GEC 28A

RIVLIN

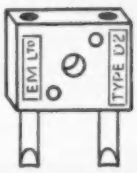
PRECISION WIREWOUND RESISTORS

Resistors to any tolerance to ± .1% □ Special types to as low as 0.01% □ High stability and low temperature co-efficient, of course □ Resistance Standards too, with extended facilities and utterly dependable □ Made by Rivlin through specialised experience, research and manufacturing techniques □ Specify Rivlin; consult them whenever demands are extraordinary

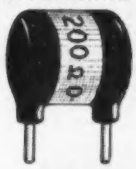
STANDARD RANGE



PLUG-IN



PRINTED CIRCUIT



STANDARD RANGE ¼w to 8w; 0.1Ω to 3MΩ. Tolerances to ± 0.1% of nominal value or 0.01Ω whichever is greater. Terminals, solder lugs or wire leads Epoxy resin encapsulated.

PLUG-IN ¼w (other ratings to order); 50Ω to 200kΩ. Tolerances to ± 0.1% of nominal value. Fitted gold plated phosphor bronze pins to fit Electro-Methods D.2 socket (other spacing to order). Tough resin encapsulated.

PRINTED CIRCUIT ¼w (other ratings to order); 50Ω to 200kΩ. Tolerances to ± 0.1% of nominal value. Fitted silver finished phosphor bronze pins to standard Printed Circuit Module. Tough resin encapsulated.

TYPE 10 S01 and 4 S01

Four resistance ranges: 1kΩ, 10kΩ, 100kΩ and 1 MegΩ, each available with sub-divisions of 10 equal parts, or four parts with choice of sub-divisions of either 1/10, 2/10, 3/10 and 4/10, or 1/10, 2/10, 2/10 and 5/10 of total value.

Available accuracies: 1%, 0.1% and 0.01%. Max. power dissipation: 1 watt per sub-division. Temperature co-efficient: ± 0.002% per °C.

OTHER TYPES INCLUDE

S01 Seven resistane ranges covering 0.1Ω to 100kΩ Standard models: 4 and 2 Terminal Accuracies: 0.1Ω, 1% and 0.2%; 1Ω, 1% and 0.1%; 1kΩ to 100kΩ, 1%, 0.1% and 0.01%.

SS2 Three resistances: 0.0001Ω, 225W; 0.001Ω, 22.5W; and 0.01Ω, 2.25W Available accuracies: 1% and 0.2%.

S01

SS2

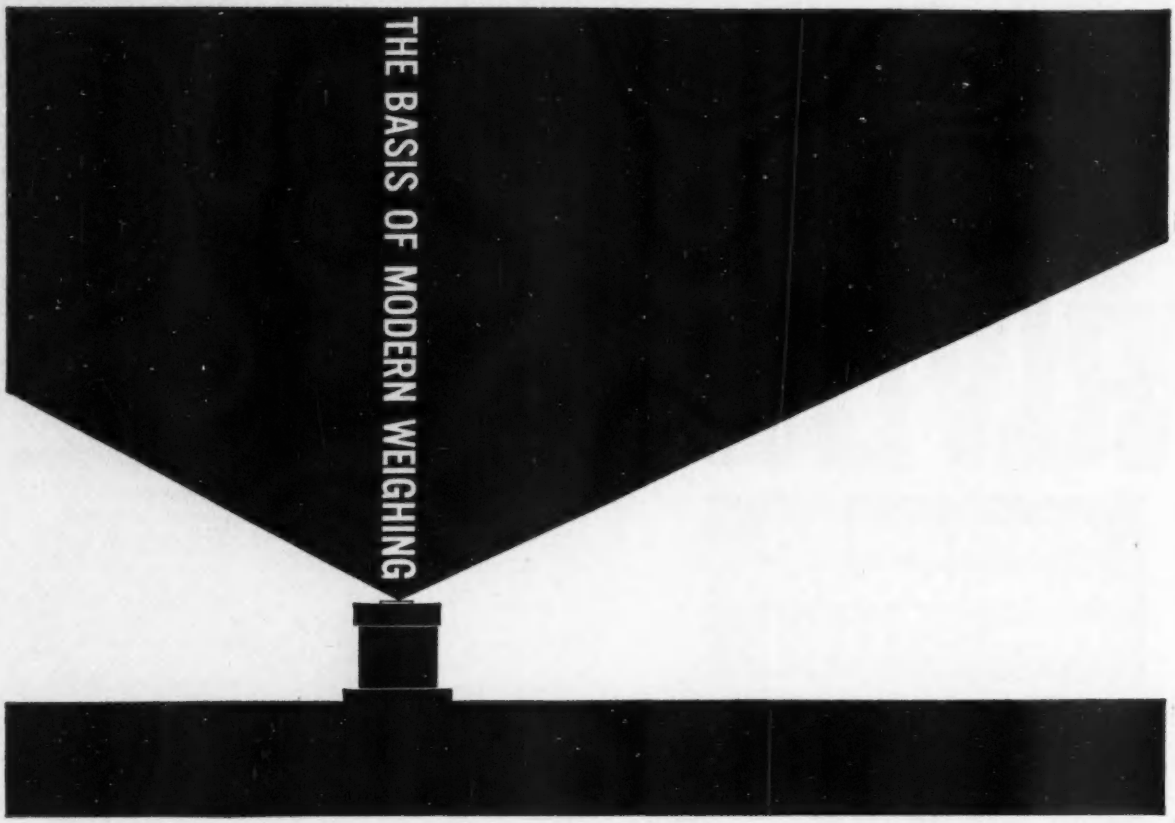
TYPE 10 S01 & 4 S01

PRECISION RESISTANCE STANDARDS

GD512

ril

RIVLIN INSTRUMENTS LIMITED
DOMAN ROAD · CAMBERLEY · SURREY
Tel: Camberley 2507/8 · Grams: Rivlectron Camberley
London Office. Tel: Swiss Cottage 3038



THE NOBEL LOAD CELL

A superior weighing device of first class constructional design employing unbonded strain gauges, giving high zero stability and excellent overload features.

Associated equipment of equally high standard provides facilities for remote control, visual display of output or permanent records in the form of print, punched card or tape from any number of cells.

In many cases existing beam and balance weighers, constant rate feeders and similar devices can be extensively controlled by means of our "Rota-weigh", "Multi-Batch" or special controllers specifically designed to meet customer's requirements. If you are considering an entirely new weighing-system or altering your existing plant, talk it over with us — our experience may be what you are looking for.

- **Accuracy — better than 0.25% of f.s.d.**
- **High zero stability.**
- **High long term stability on load.**
- **Good overload facilities.**
- **Fail safe in event of gross overload.**
- **Oil filled and hermetically sealed.**
- **Corrosion resistant**
- **5 standard types to weigh up to 50,000 lbs.**

Enquiries should be addressed to:—

INSTRUMENT DIVISION

HIGH CHURCH STREET · NEW BASFORD · NOTTINGHAM

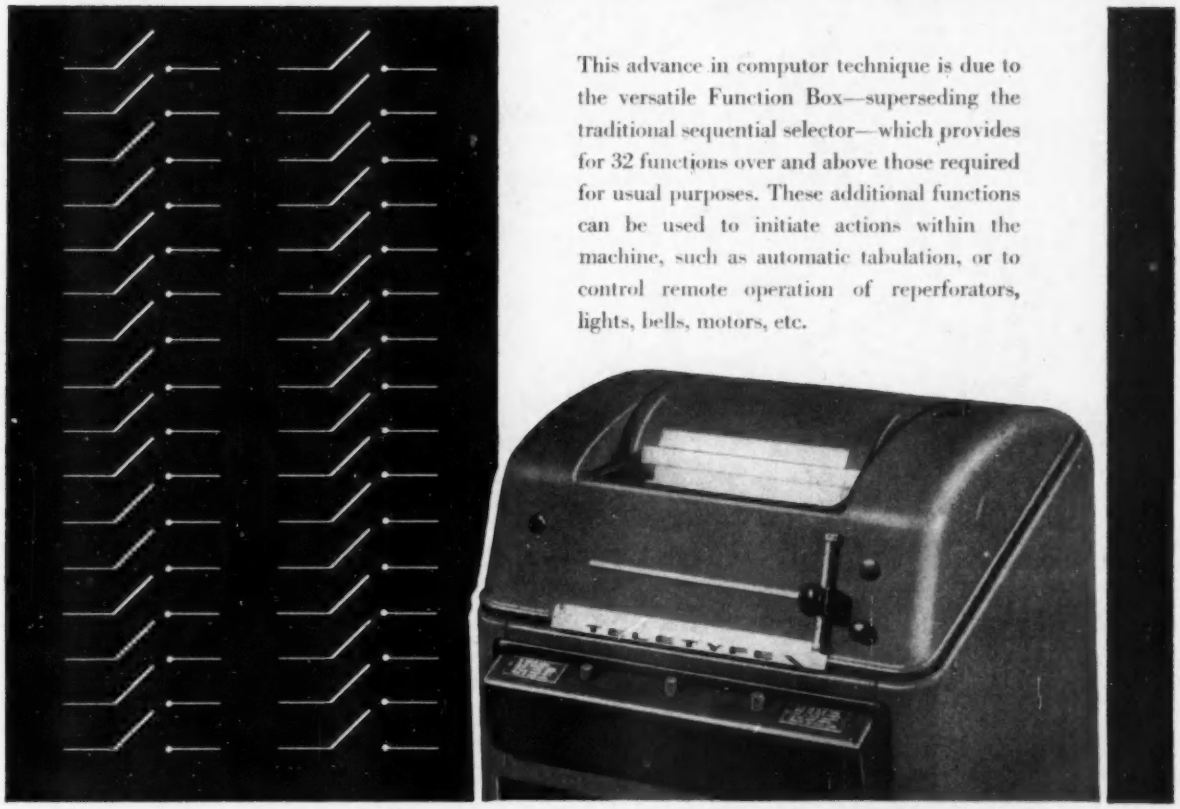
ERICSSON

ERICSSON TELEPHONES LIMITED · HEAD OFFICE · 22 LINCOLN'S INN FIELDS · LONDON W.C.2

ACCENT ON ACCURACY ...AND SPEED

This new read-out system brings greatly increased speed to what has always been the slowest stage in computor operation. With the Model 28 Page Printer it is possible, by using code combinations, to perform local and remote functions without sacrificing a single character code combination.

UNIQUE DIRECT READER FOR COMPUTORS AT A MODERATE COST



This advance in computor technique is due to the versatile Function Box—superseding the traditional sequential selector—which provides for 32 functions over and above those required for usual purposes. These additional functions can be used to initiate actions within the machine, such as automatic tabulation, or to control remote operation of reperforators, lights, bells, motors, etc.

No larger than an electric typewriter and with interchangeable typing heads, the Model 28 Page Printer requires little or no maintenance. Send for full details to:

Westrex Company Limited

COLES GREEN ROAD LONDON NW2 TELEPHONE GLADSTONE 5401/8

The Westrex Company Limited is a Division of Litton Industries

Chasing after the right transistor?

If the transistor you're after is a rare specimen with unusual characteristics you can go a long way before you finally pin it down. Give us an idea of the kind of specimen you are seeking and we may be able to give you the answer.

The list of Ediswan Mazda transistors is constantly growing; a request on your letterhead will bring you details of the very latest types.

This could be it!

If you are looking for a VHF pnp drift transistor, the XA131, a recent addition to our range, may be the one you want. It is suitable for use as a **Local Oscillator up to 250 Mc/s or an R.F. Amplifier up to a frequency of 100 Mc/s.**

EDISWAN
MAZDA
SEMICONDUCTORS

Associated Electrical Industries Limited
Radio & Electronic Components Division
Semiconductor Department, 155 Charing Cross Road, London W.C.2
Tel: GERrard 8660 Telegrams: Sieswan Wescent London
CRC 15/74

THERE'S A CAPACITOR HERE...
TMC
to meet YOUR need exactly
T.M.C.'s extensive range includes low-priced capacitors for run-of-the-mill uses as well as those for top-quality precision work. Here are some of the applications for which T.M.C. capacitors are being so widely used:
RADIO AND TV EQUIPMENT · ELECTRONIC EQUIPMENT
COMPUTERS · TELECOMMUNICATIONS · FILTERS · RADAR
PULSE FORMING NETWORKS · INTERFERENCE SUPPRESSION
POWER FACTOR CORRECTION · PHASE SPLITTING
ENERGY STORAGE
Capacitance Tolerances from 0.1%
Working Voltages up to 300kV.
Whatever *your* need, you'll find that the ideal capacitor is made by T.M.C. whose knowledge, experience and technical resources will be placed at your service if you write for further information.

TMC CAPACITORS

TELEPHONE MANUFACTURING COMPANY LIMITED
Components Division · Cray Works · Sevenoaks Way · Orpington · Kent
Telephone: Orpington 26611

SYNCHROS & SERVOMOTORS

are readily available in a range of more than 100 types, in sizes from 08 to 23. They meet the exacting requirements of United States, British and N.A.T.O. Military specifications.

Ask for your copy of the latest Synchro Broadsheet. Data sheets and prices for specific types on application.

MUIRHEAD PRECISION ELECTRICAL INSTRUMENTS

MUIRHEAD & CO. LIMITED,
Beckenham, Kent, England.
Telephone: Beckenham 4888

MUIRHEAD INSTRUMENTS LIMITED,
Stratford, Ontario, Canada.
Telephone: 271-3880

MUIRHEAD INSTRUMENTS INC.,
441 Lexington Ave., New York 17, N.Y., U.S.A.
Telephone: Murray Hill 2-8131

491

MUIRHEAD

TECHNIQUE

WELL

READ

THE

WORLD

OVER

"Technique"—published quarterly and available without charge—gives news about the latest designs, developments and applications of Muirhead equipment.
"Technique" is received—and read—by over 20,000 people throughout the world. Write to us to-day and have your name placed on our mailing list.

MUIRHEAD

MUIRHEAD & CO. LIMITED
BECKENHAM·KENT·ENGLAND

EE 30 019 *for further details*

HUNDRED MILLION MEGOHMMETER

MEGOHMMETER

Type IM5

FOR LAB WORK

Measurement on capacitors, resistors, and insulating materials.

High accuracy and stability.

Large meter, 6" scale.

Provisions for measurement on three-terminal resistors: built-in leakage current guard.

Measuring Range:

1 Megohm to 100 Million Megohms.

Scale calibrated from 1 Megohm to 100 Megohms, range multipliers: x 1, x 10,—x 10^6.

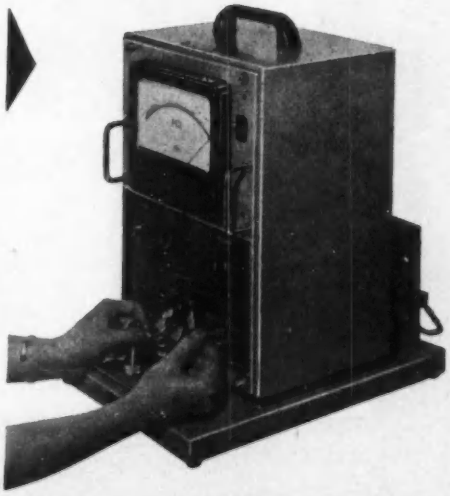
Test Voltages:

50, 100, 200, 500, and 1000 volts d.c.

The complete measuring range can be used at all test voltages.

Accuracy:

2% to 5% depending on the range.



FOR PRODUCTION

1000 to 2000 components tested per hour when Megohmmeter is used with the new electrically operated Component Jig, type KPH1M1.

The clamping mechanism is actuated by the function selector of the Megohmmeter. Adjustable spacing between terminal posts.

Automatic charging of capacitors permits fast operation, even on large units.

Provisions for fast go-no-go measurements.

Capacitors automatically discharged before release.

Write for complete information

Radiometer offers a line of 50 different instruments

AF-OSCILLATORS
R-L-C BRIDGES
SIGNAL GENERATORS
VACUUM-TUBE VOLTMETERS
WAVE ANALYSERS
ELECTROCHEMICAL INSTRUMENTS

RADIOMETER

72 Emdrupvej, Copenhagen NV, Denmark

Represented in Great Britain by

Livingston Laboratories Ltd.
Retcar Street, London, N.19

EE 30 020 *for further details*

established success

Plessey

UK-AN

Registered Trade Mark

connectors

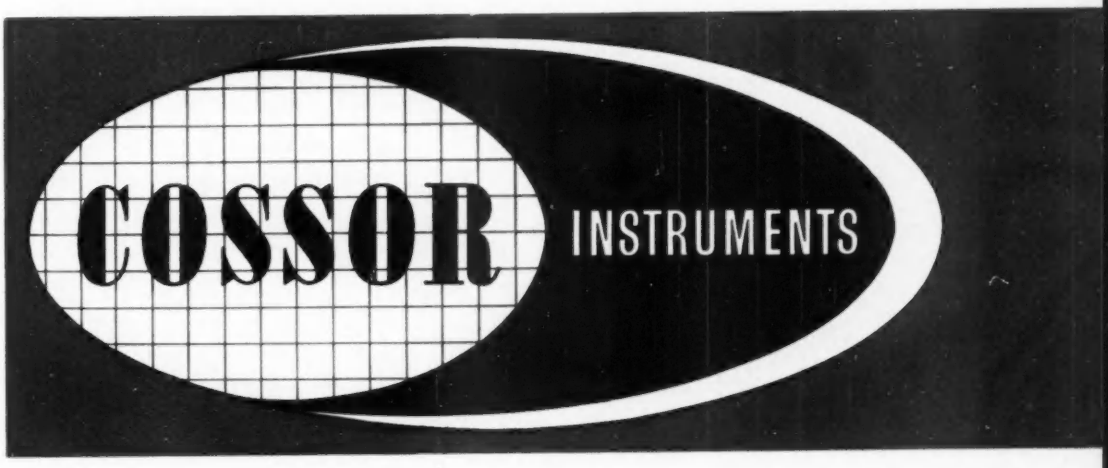
- 2 kV r.m.s. all contacts
- −65°C to + 190°C working
- 30 p.s.i. pressure seal
- 180 contact arrangements
- Climatic proof
- Waterproof
- Shock proof
- Vibration proof
- Crimped connections
- Fireproof and hermetically sealed types
- Interchangeable with A.N. or M.S. connectors

This has prompted the publication of a fully descriptive booklet, No 109, which sets out in detail the characteristics of these outstanding connectors. Write for a copy now—on Company-headed paper, please.

Wiring and Connectors Division
THE PLESSEY COMPANY LIMITED
Cheney Manor · Swindon · Wilts · Swindon 6251

Overseas Sales Organisation:
Plessey International Limited · Ilford · Essex
Ilford 3040

CW21a



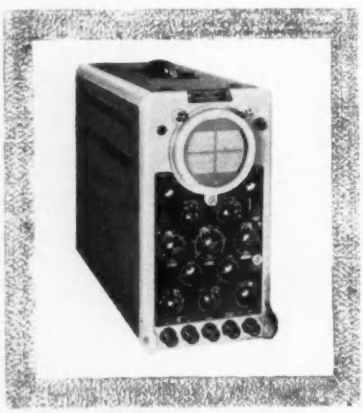
THE NEW SYMBOL OF SUPREMACY IN THE INTERNATIONAL FIELD OF ELECTRONIC INSTRUMENTATION

This new trade-mark symbolises the Cossor approach to your problems —you will see it on a wide variety of instruments: signal generators, LCR bridges, voltmeters, amplifiers, transducers, transistor testers, and a host of other equipment of advanced design, as well as oscilloscopes. It is your assurance of a flexible outlook brought to your problems, and of objective technical advice. It is the badge of an after-sales service equally concerned with you in the successful solution of your problems by Cossor instruments. It is your invitation to come to Cossor for the best possible electronic tools and service.

Cossor Instruments Ltd.
COSSOR HOUSE, HIGHBURY GROVE, LONDON, N.5, ENGLAND
Telephone: CANonbury 1234 (30 lines) Telegrams: Cossor, Norphone, London
Cables: Cossor, London. Code: "Bentley's Second"

so you think COSSOR specialise only in

THEN TAKE A LOOK AT THESE OSCILLOSCOPES



Single-beam Model 1065

Response DC to 11Mc/s (30% down). For fast pulse phenomena examination in TV, radar computers, and pulse circuitry. Sensitivity: 250mV/cm. Sweep delays 0.1m sec and 1.0m sec.

Single-beam Portable Model 1039

Response 25c/s to 1.5Mc/s (30% down). For industrial and service engineering in field and workshop—for alignment of TV and FM receivers. Sensitivity: 150mV/cm. Weight 10½lb.

Split-beam Portable Model 1091

Response DC to 3Mc/s (30% down). For Production line testing and laboratory work. Sensitivity: 50V-0.5V/cm (identical amplifiers).

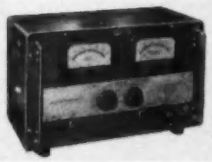
Cossor make the most extensive and advanced range of oscilloscopes in Europe. The very extent of the Cossor range ensures that there's a Cossor model to cater most efficiently and economically for your particular needs without undue and wasteful overlap. And the range is continually growing and advancing—new concepts—new models—new facilities, many of them unique, as for instance, a range of plug-in units for a multiplicity of purposes on the Cossor model 1076 for DC to 60/100Mc/s.

But for ordinary everyday use of oscilloscopes, the extraordinary Cossor reliability is your investment and safeguard. The logical positioning of the controls for simplicity and ease of use will rapidly familiarise you with any Cossor model, making it your most hard-working and versatile investigating and measuring instrument.

Signal Generators
Amplifiers
Power Supplies
Transistor Testers
LCR Bridges
Valve Analysers
Hydraudynes
Transducers
Signal Delay Units
Signal Delay Cables

Square Wave Generator Model 1090. Rise Time: 3 to 4 millimicroseconds, gives 0.5V into 75Ω at frequencies 0.30 – 1.25 Mc/s.

General Purpose Signal Generator Model 1450, Frequency: 150kc/s to 390Mc/s, Accuracy ±1% up to 33 Mc/s, ±2% over. Doubly Screened, internal and external modulation.



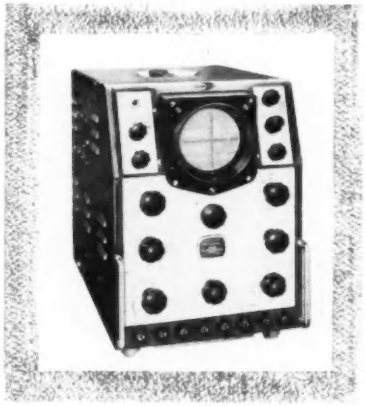
Laboratory Power Supply Model 1328, Transistorised, for transistorised equipment. Output continuously variable 0–30V at 1A. Ripple < 1mV.

Wide-band Amplifier Model 1439. For simultaneous distribution from common aerial of all bands I, II and III to number of TV and VHF receivers.

L C R Bridge Model 1446. With miniature CRT Indicator. 10UH to 10H, 10pF to 100pF, 1Ω to 100MΩ Quick and accurate.

Transistor Tester Model 1325. For quick and accurate measurement of the parameters of all transistors including high gain and power transistors.

— JUST SOME OF THE COSSOR RANGE



Split-beam Model 1035

Response (30% down): A1 5c/s to 5 Mc/s, A2 5c/s to 250kc/s. For Research and industrial applications requiring high sensitivity and wide band width

Split-beam Model 1049

Response (30% down): A1 DC to 200kc/s, A2 DC to 400kc/s. For servo control, electrical engineering, vibration analysis, electromedical instrumentation

Split-beam Model 1059

Response (30% down): 1c/s to 10Mc/s. For precision measurements over a wide band of frequencies. Sensitivities calibrated 100 mV/cm to 10V/cm (identical amplifiers)

The Cossor range is growing all the time— change up to Cossor . . .

COSSOR INSTRUMENTS

Cossor Instruments Ltd.

Cossor House, Highbury Grove, London N.5
Telephone CANonbury 1234
a member of the Cossor Group of Companies

. . . and now the COSSOR 1076

Acknowledged by industry as Europe's most advanced oscilloscope

This is a most versatile oscilloscope with practically every conceivable facility — by means of a comprehensive range of plug-in units, the instrument covers the entire field of oscillography in all its applications to nucleonics, communications, semi-conductor research, servo control, mechanical engineering and indeed *all industry*. Twenty-four calibrated time base ranges are provided, voltage and time calibration permitting accurate measurement of waveforms, which can also be recorded by camera. Advanced technique of filtered forced ventilation provides silent air conditioning.

A CONSISTENT 50 MV/CM FROM DC TO 60 MC/S AND AT LEAST OF 2½ CMS DEFLECTION RIGHT UP TO 100 MC/S

Rise time:
6 to 7 Millimicroseconds

Send for full technical information and specifications
Brief descriptive list on Britain's biggest range of oscilloscopes available

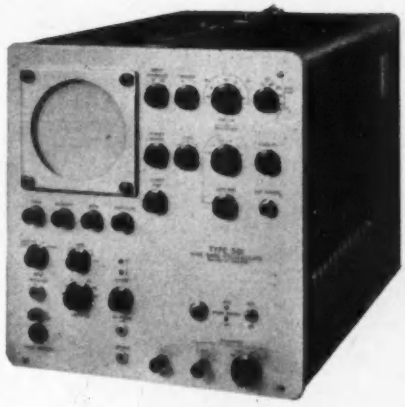
Cossor Instruments Limited

Cossor House, Highbury Grove, London, N.9. Telephone CANonbury 1234

COSSOR INSTRUMENTS

OSCILLOSCOPES OF QUALITY
versatility and value

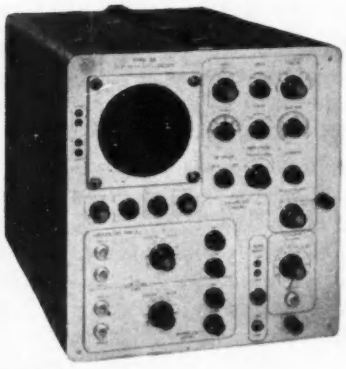
NAGARD LTD



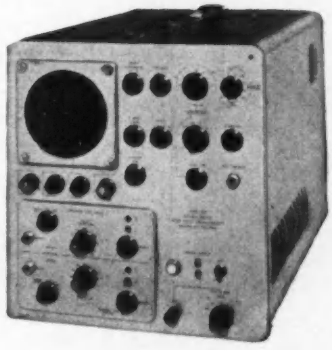
TWO CHANNEL

with plug-in pre-amps
providing various input
conditions accurately calibrated

TYPE 301
High Speed
D.C. to 20 Mc/s
Single Beam

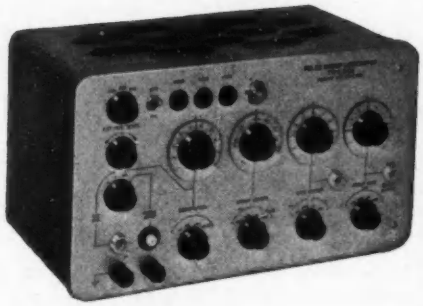


311 TYPE
with range of plug-ins such as:—
High sensitivity—100μV/cm to 150 Kc/s or
Wide Band—1mV/1 cm. D.C. to 1 Mc/s
both differential inputs

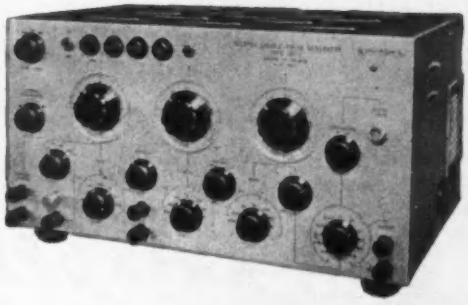


TYPE 321
D.C. to 20 Mc/s—
10 KV High writing speed,
with range of plug-ins
for various conditions

ACCURATE PULSE GENERATORS
essential and reliable electronic test gear



5101 TYPE
Square wave and pulse group generator—
fully calibrated and with 10mV—
100V continuously variable output

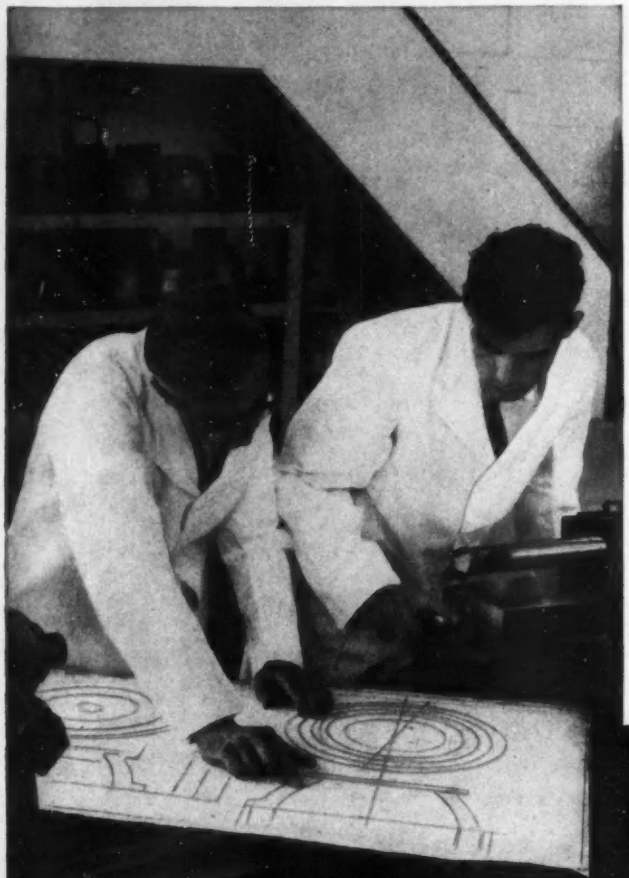


TYPE 5002
10,000,000—1 Range of Pulse Dimensions
Accurately calibrated
single or double pulses

NAGARD LIMITED, 18 AVENUE ROAD, BELMONT, SURREY Tel: VIG 9161-2

EE 30 022 *for further details*

Workshop angle and D.O. viewpoint



Now that machining costs are so high, the legibility of working drawings has become of supreme importance. ILFORD Azoflex photoprinting papers give maximum legibility combined with speed of production and long life in normal storage and use. That is the workshop angle combined with the viewpoints of the drawing stores and D.O.

More specifically, the D.O. is interested in the Azoflex dyeline process because no ducting or darkrooms are necessary ; the process is dry, there are no fumes or excessive heat generated.

An economical and time-saving feature is that the correctness of exposure/machine speed can be gauged and adjusted immediately, even in the largest Azoflex models, because the Azoflex copy emerges fully processed in seconds and within view and easy reach of the operator. Inexperienced staff quickly grasp the simple details of Azoflex machine operation.

Photograph by courtesy of Duraglass Limited

ILFORD *Azoflex*

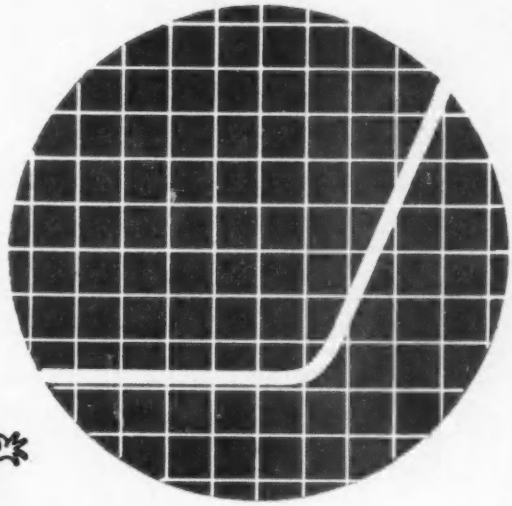
Your company might benefit . . .

Many business and industrial concerns find that it pays to hire certain AZOFLEX machines — rather than buy them outright. Enquiries will be treated with the utmost discretion, and will not commit you in any way.

Photoprinting Papers and Machines

ILFORD LIMITED · INDUSTRIAL SALES DEPARTMENT AZ22G · ILFORD · ESSEX

EE 30 023 *for further details*



"Well, what's so **special** about that?"

DEFINITION

"O.K.—it's an ordinary characteristic but what isn't so ordinary is that we have got definition of this valve's performance. Definition in a special way that is. For instance, we know just what 'spread' we can expect in every batch that is delivered, and we have an indication of the spreads that we can expect over life.

This information is a tremendous help when you're designing equipment that's got to be reliable and you get it on Mullard Special Quality valves. You get this information because of the work they put in at their quality and test laboratories; with it you can design circuits that allow for possible valve variations and so achieve standards of equipment dependability that might otherwise not be possible.

Closely controlled characteristics are a feature of some Mullard Special Quality valves—others have a particularly long life expectation and some are designed for application where physical shock and vibration are likely to be experienced, some even have a combination of these features."

"When it comes to selecting the right valve for the right job, you know, the people at Mullard House are very helpful—they can give you all the facts you need and what's more they're always happy to discuss problems with you."

Mullard Limited Government and Industrial Valve Division,
Mullard House, Torrington Place, London, W.C.1. Telephone: LAN 6633

MVTA381

EE 30 024 *for further details*

wise engineers use *ROCOL* lubricants

to insure against breakdown and to increase the period between essential maintenance operations on difficult, perhaps dangerous to get at installations where continual maintenance is inconvenient as with sealed underwater T.V. cameras. Plating tough, wear resistant Molybdenum Disulphide—the most advanced lubricant known to engineering science—on to all bearing surfaces, Rocol Molybdenum Disulphide stays in action in conditions of high pressure or extremes of temperature, up to 100,000 lbs. p.s.i. and 1000°F. Find out more about Rocol Lubricants—write for technical details and for advice on your particular problem.

★ *Deep Sea Underwater Television Camera manufactured by PYE LIMITED, CAMBRIDGE, ENGLAND. All working parts lubricated by ROCOL lubricants which are solely recommended.*

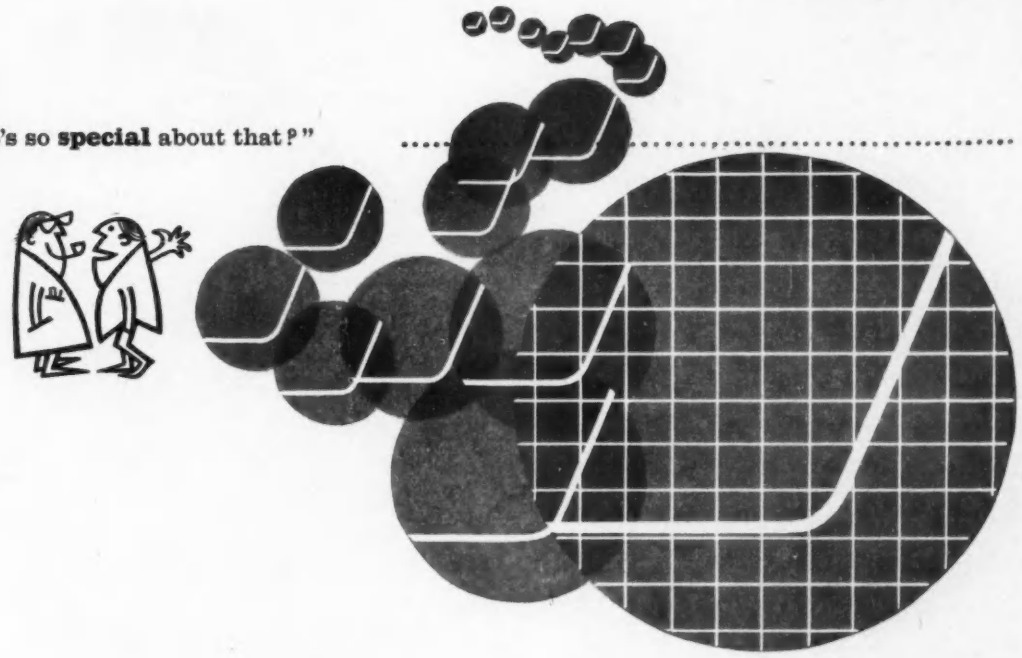
USE *Rocol* MOLYBDENISED LUBRICANTS

ROCOL LIMITED
GENERAL BUILDINGS, ALDWYCH, LONDON W.C.2. TEL: HOLBORN 1985
ROCOL HOUSE, SWILLINGTON, LEEDS. TEL: GARFORTH 2261

1293xa

EE 30 025 *for further details*

"Well, what's so **special** about that?"



LONG-LIFE

"It's a valve characteristic that looks no different from many others—what is special is that it will be maintained for a much greater period than you would normally expect.

This feature of long consistent performance is typical of many of the Special Quality valves they make at Mullard. They achieve these standards by combining sound design with first class materials and, of course, thorough testing. In a single year, Mullard carry out something like 30 million valve hours of life testing on these types. Obviously, the many valves used are subsequently destroyed.

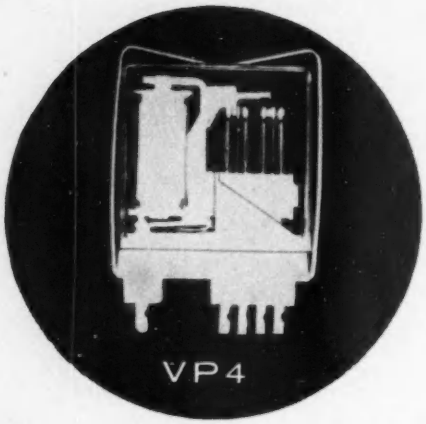
You can see that with this kind of background, equipment manufacturers—and users—can specify Mullard long life Special Quality types and be pretty sure that they won't be caught out by valve failures. And that's important nowadays when so much equipment serves vital functions where failure can mean real trouble.

Long life is only one feature of the Mullard Special Quality range; there are types available with closely controlled characteristics and others are particularly rugged, some even have a combination of these features."

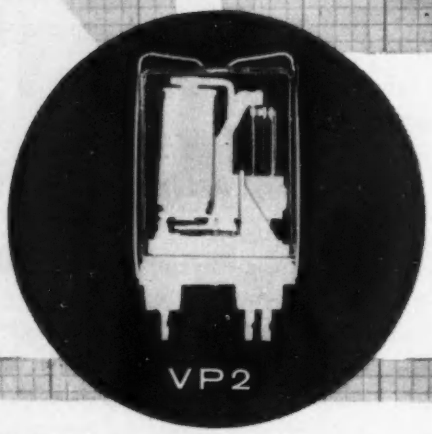
"Mullard, as you probably know, are most helpful when it comes to selecting the right valve for a particular job—the data they can let you have is really comprehensive and the people at Mullard House are always happy to discuss problems with you."

Mullard Limited Government & Industrial Valve Division
Mullard House, Torrington Place, London, W.C.1. Telephone: LANgham 6633

MVTA 405



NEW!



MINIATURE PLUG-IN RELAYS

British made . . .

for long life

and perfect contact.

Features:

* Size:
  Type V.P.2. 0·75″x0·96″ Panel height 1·175″ (with socket 1·35″)
  Type V.P.4. 0·75″x1·18″ Panel height 1·175″ (with socket 1·35″)
* 2 or 4 pole changeover
* Operating voltages: 6–138v D.C.
* Operating times: 3½ to 7½ milleseconds
* Operating life: in excess of 10^7 operations
* Contact ratings: 1 amp at 100v. Maximum watts: 30w
* Contact material: fine silver. Other contact materials will be available at a later date
* Plug-in and fitted with dust cover.

Varley
REGD. TRADE MARK

miniature plug-in relays

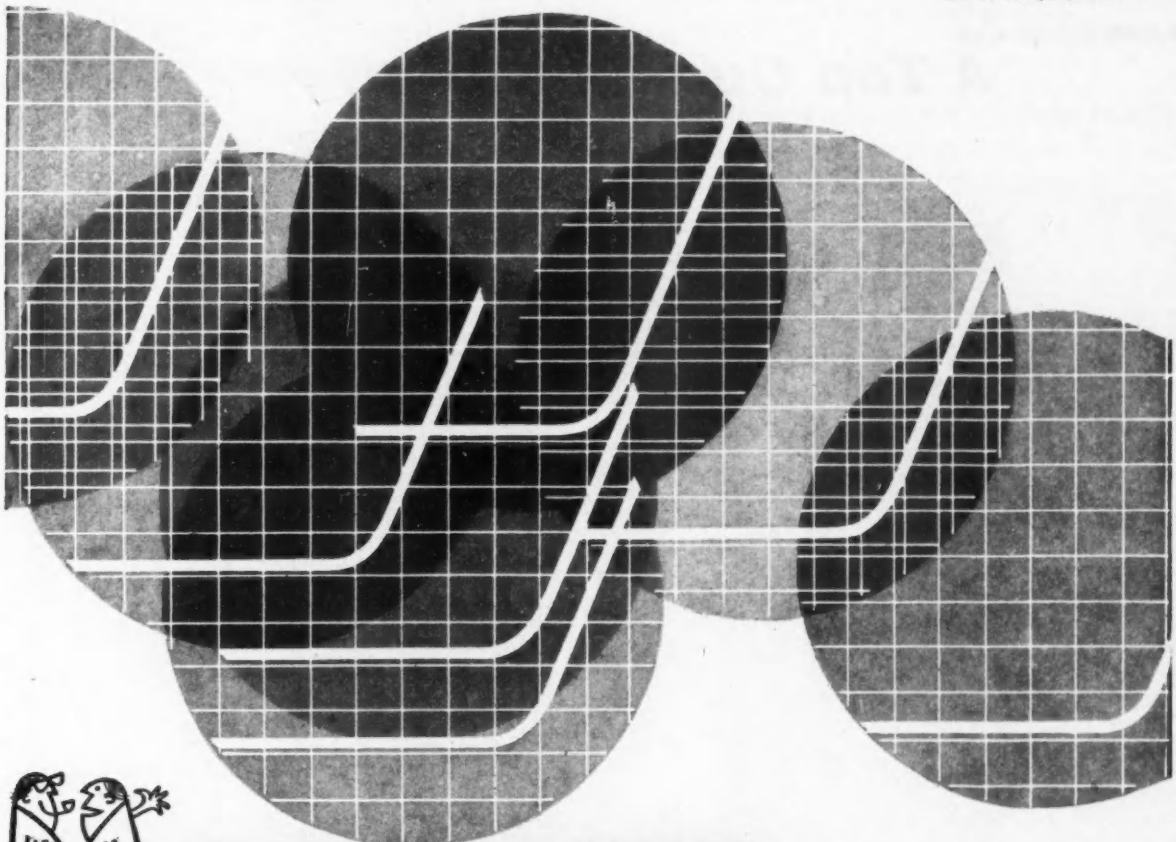
British made

GUARANTEED EX-STOCK DELIVERY

For further information write:—

OLIVER PELL CONTROL LTD.
Cambridge Row, Burrage Rd., Woolwich, S.E.18
Telephone: Woolwich 1422 (7 lines) Telegrams: Olipel, London, S.E.18

TA 4232



"Well, what's so **special** about that?"

RUGGEDNESS

"Yes it's a straightforward enough valve characteristic, but it *is* special because it will be maintained in spite of the punishment—shock and vibration—it will get in the equipment where it is installed.

You see, right the way through Mullard Special Quality rugged types are designed and built to the tightest specifications—tolerances are finely controlled, assembly methods are extremely accurate and welding techniques are of the highest standards. Indeed, all the staff who work on them are carefully selected and specially trained—even completely new manufacturing techniques have been devised to make sure that the end product is as rugged as possible.

When it comes to equipment that must stand up to a certain amount of shock and vibration these Mullard Special Quality valves are just the job—a worthwhile insurance against valve failure and resulting equipment breakdown, with the high servicing costs that go with it.

Ruggedness is only one feature of the Mullard Special Quality range; there are types available with extra long life expectation and others with closely controlled characteristics, some even have a combination of these features."

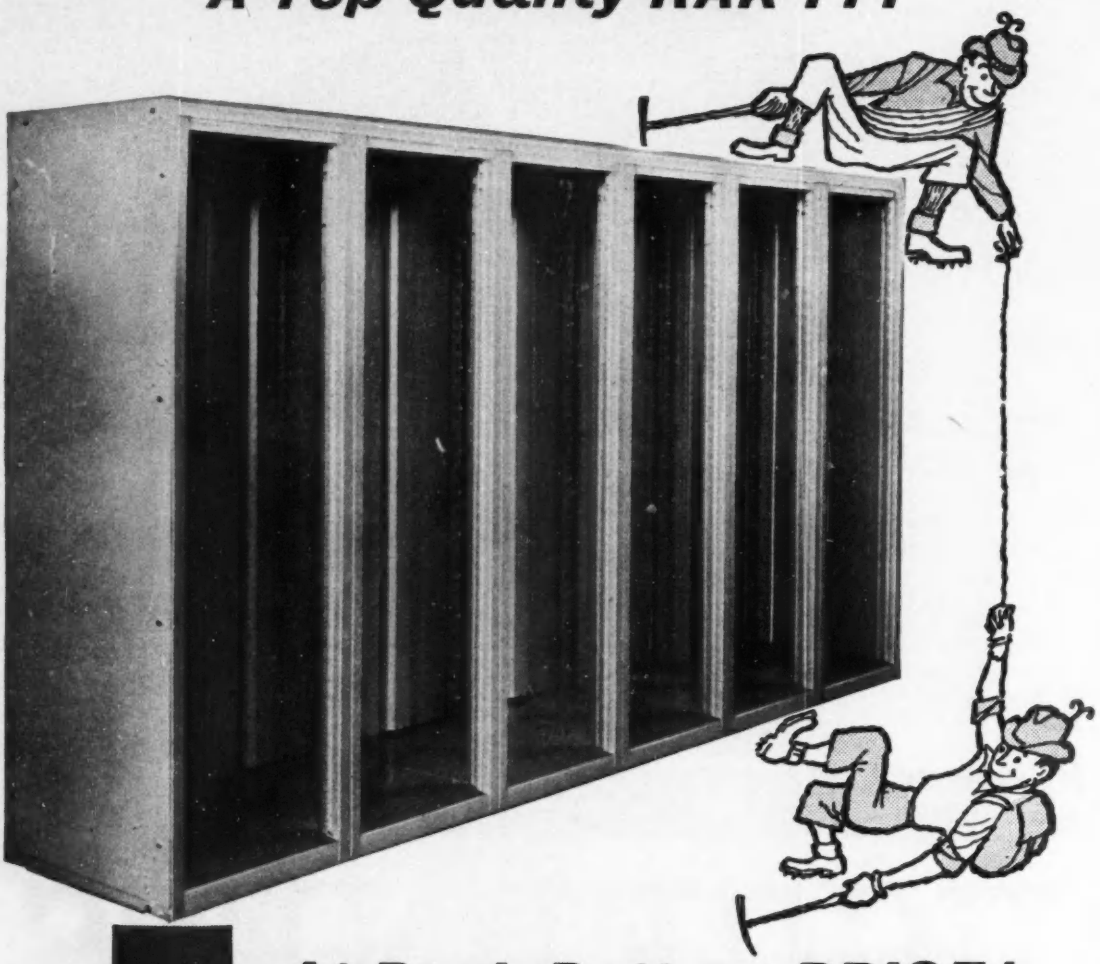
"So far as information is concerned, Mullard can let you have all you need on any particular valve type. What's more, the people at Mullard House, who are pretty knowledgeable on these things, will always help in selecting the best valve for a particular job."

Mullard Limited Government & Industrial Valve Division, Mullard House, Torrington Place, London, W.C.1. Telephone: LANgham 6633

MVTA 406

EE 30 028 *for further details*

A Top Quality RAK . . .



IMRAK

At Rock Bottom PRICE!

6 feet Multi-Bay IMRAK at £27.1.8 per bay. *And* there is a Quantity Discount reduction to £25.9.2 each by the 100.

Complete six-bay rak as illustrated with hinged and quick release rear doors and detachable side panels—only £169.0.11. Fitted with strong yet elegant side doors on 'lift-off' concealed hinges—£174.18.3.

IMHOFS

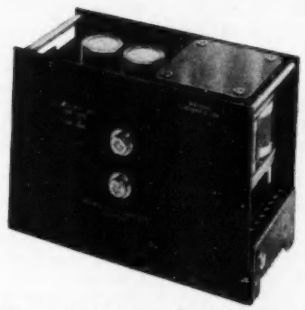
Imhofs new Imrak International Rak is a completely universal flexible rack system. It can carry British, American and Continental fixings. It packs flat for easy storage or transportation. There are five standard types, each made in four different heights and four different plan sizes—a choice of 80 different standard racks in this new series! There is a choice of normal front panels, one piece front panel or recessed front panels with removable door. Skilful design ensures an elegance of appearance that enhances but does not dominate the instruments. The standard hammertone finishes are ideal for reliability and long service; other finishes are available to special order.

Alfred Imhof Ltd., Dept. F.2, Ashley Works, Cowley Mill Road, Uxbridge, Middlesex, England. *Uxbridge 37123*

London Showroom: 112-116 New Oxford Street London WC1 MUSeum 7878

IMHOFS AGENTS OVERSEAS

Algeria: E.G.E.E., Paris (19)
Australia: Aladdin Industries (Pty) Ltd., Stanmore, NSW
Belgium: Rogelec, Ghent
Canada: Measurement Engineering Ltd., Arnprior
Denmark: Tage Schouboe, Copenhagen N
Finland: Oy Scienta Ab, Helsinki
France: E.G.E.E., Paris (19)
Germany: Sunvic Regler GMBH Solingen—Ohligs
Holland: J. Th. van Reijsen, Delft
Italy: Stuart Culley, Milan
Mexico: Aluminio Arquitectonico S.A., Mexico D.F.
Morocco: E.G.E.E., Paris (19)
New Zealand: Imarex Ltd., Auckland C3
Norway: Birger Christensen, Oslo
Portugal: Projectos e Construcoes Lda, Lisbon
South Africa: Switchcraft (Pty) Limited, Johannesburg
Sweden: Electronlund AB, Malmo C
Switzerland: Walter Blum, Zurich 2/39
Tunisia: E.G.E.E., Paris (19)
U.S.A.: Bud Radio Inc., Cleveland 3, Ohio
British Guiana: Davsons Caribbean Agencies Ltd., Georgetown



Model T109, pre-set 0(nominal) - 50V max, 2A

Model TIII, variable 0-50V, 5A

The Roband philosophy of power supplies is to provide *exactly* your *specific* requirements in units of lasting reliability. Roband probably manufacture the widest and most comprehensive range of power supplies available anywhere today. Unrivalled Roband reliability is built into the power supplies by unstinted use of high grade components, interservices approved wherever practical, and by consistently underrunning them — transistors for example at never more than 50% of manufacturers' ratings. Painstaking Roband engineering ensures ample ventilation and mechanical strength for the severest conditions.

All outputs are isolated to provide highly stabilised positive, negative, or floating supplies with negligible ripple.

Open chassis units are supplied pre-set to any voltage from zero nominal to maximum, a pre-set control allowing a small variation. Any other voltage can be obtained by simple adjustment within the unit.

Model	D.C. Output Volts	D.C. Output Current	Effective Resistance	Voltage Stability	Ripple	Size	Weight	Price ex-Works
T SERIES OPEN CHASSIS PRE-SET VOLTAGE UNITS (Mains 200/250V A.C. 100/125V models available)								
T98	6V—18V	0·5A	0·08Ω	0·1%	1mV	5⅜" × 2⅜" × 4" ht.	3¾ lbs.	£ 32- 0-0
T100	30V max.	1·0A	0·03Ω	0·1%	1mV	7½" × 4½" × 5¾" ht.	5½ lbs.	£ 45- 0-0
T108	50V max.	1·0A	0·05Ω	0·1%	1mV	8½" × 5½" × 6½" ht.	8 lbs.	£ 55- 0-0
T109	50V max.	2·0A	0·05Ω	0·1%	1mV	10½" × 5½" × 7½" ht.	13 lbs.	£ 70- 0-0
T110	30V max.	5·0A	0·01Ω	0·1%	1mV	13½" × 8½" × 7¾" ht.	23 lbs.	£ 98- 0-0
T114	30V max.	10·0A	0·01Ω	0·1%	1mV	17" × 10" × 8½" ht.	39 lbs.	£135- 0-0

Please order as follows: Type No./Voltage required. For example: T109/45 is a 45 volt 2A unit.

T SERIES FRONT PANEL VARIABLE UNITS (Mains 200/250V A.C. 100/125V models available)								
T99	0–±30V	0·5A	0·1 Ω	0·1%	1mV	9¾" × 5½" × 5" ht.	8 lbs.	£ 59-10-0
T101	0–±50V	1·0A	0·1 Ω	0·1%	1mV	13⅜" × 10½" × 9½" ht.	19½ lbs.	£ 93- 0-0
T102	0–±30V	2·0A	0·05Ω	0·1%	1mV	16⅜" × 10½" × 10½" ht.	30 lbs.	£100- 0-0
T103	0–±30V	1·0A	0·05Ω	0·1%	1mV	13⅜" × 10½" × 9½" ht.	19½ lbs.	£ 85- 0-0
†T104	0–±30V 0–±30V	1·0A 1·0A	0·05Ω 0·05Ω	0·1% 0·1%	1mV 1mV	16⅜" × 10½" × 10½" ht.	30 lbs.	£129- 0-0
T105	0–±50V	2·0A	0·05Ω	0·1%	1mV	16⅜" × 10½" × 10½" ht.	30 lbs.	£118- 0-0
T106	0–±100V	1·0A	0·1 Ω	0·1%	2mV	*21½" × 14½" × 11¾" ht.	46 lbs.	£149- 0-0
T107	0–±100V	2·0A	0·07Ω	0·1%	2mV	*21½" × 14½" × 11¾" ht.	60 lbs.	£183- 0-0
T111	0–±50V	5·0A	0·01Ω	0·1%	2mV	*21½" × 18½" × 11¾" ht.	64 lbs.	£155- 0-0
T112	0–±50V	10·0A	0·01Ω	0·1%	2mV	*21½" × 20½" × 13½" ht.	101 lbs.	£245- 0-0
T113	0–±30V	20·0A	0·01Ω	0·1%	2mV	*21½" × 21" × 16¾" ht.	139 lbs.	£315- 0-0

*Panel and chassis withdrawable to fit 19" rack. †Note that T104 has two independent floating sections.

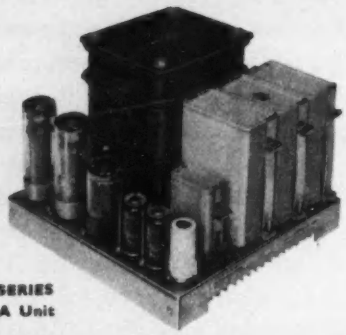
TRANSISTORISED REGULATED POWER SUPPLIES

ROBAND ELECTRONICS LIMITED
Beulah Works, Beulah Road, Thornton Heath, Surrey
Telephone: LIVingstone 6606/7/8

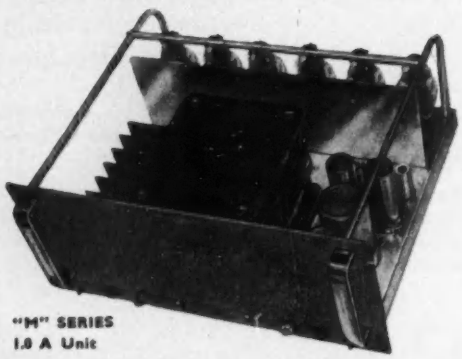
MADE AND GUARANTEED BY

ROBAND

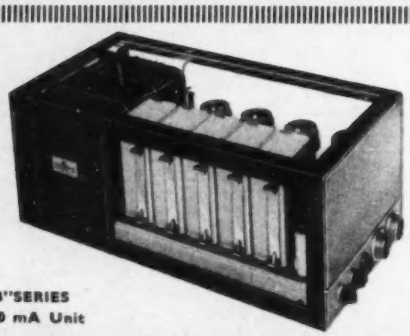
EE 30 030 *for further details*



"M" SERIES
200 mA Unit



"M" SERIES
1.0 A Unit



"B" SERIES
500 mA Unit

M Series open chassis units

Since their introduction some years ago, these chokeless supplies have firmly established their superiority over more conventional circuits.

Their smaller size—excellent high frequency performance and stable operation down to at least 1 c.p.s.—reliability at elevated temperatures and safe operation for ±10% mains changes—coupled with the highest engineering standards confirm the "M" Series as the first choice in stabilised units.

M Series front panel units

The front panel units have been designed for use with standard 19" racks. The panel is finished in B.S.S.632 grey (or any other colour at no extra cost) and houses the handles, mains and H.T. switches, fuses and indicator lamps. The input and outputs terminate on Plessey Mark 4 connectors (or any suitable alternative if requested) at the rear of the chassis.

B Series rugged reliable units

Probably the most advanced series of open chassis units available today and characterised by an extremely rugged construction and a line-up of interservices approved reliable valves. The input and outputs terminate on Plessey Mark 4 connectors (or any suitable alternative if requested) and a mains selector panel is included.

A compact welded rectangular framework of extruded angle aluminium alloy rigidly secures the 'C' core transformer and the 14 S.W.G. chassis housing the electronic sub-assembly. Because all the vulnerable components are located within the framework the risk of accidental damage is greatly minimised. The framework contains anchor nuts which facilitate mounting the units in a variety of ways. It is permissible, for instance, to secure any two units side by side to a standard 19"×7" front panel.

High efficiency silicon junction rectifiers, series valves operating as pentodes and a 'C' core transformer to H2 specification ensure a minimum temperature rise within the unit. Insulated carbon and vitreous wire-wound resistors are used throughout and the conservative design permits continuous operation at full load even when the mains are permanently ±10% from nominal.

V series regulated variable voltage units

A range of regulated variable voltage supplies for use on the bench or standard 19" racks. Minimum weight and low internal heat dissipation are obtained by using chokeless circuits, 'C' core transformers, silicon junction rectifiers and series valves operating as pentodes.

V50-50 An exceptionally stable decade controlled 0 to 500V 500mA unit. A fixed 250V 50mA negative rail and two 6·3V5A centre tapped windings are included.

The decade system enables the output to be changed incrementally with a much greater accuracy than that obtained by normal methods.

Price £137–10–0 ex-works

VACUUM TUBE

V50-50

V50-20D A 0 to 500V 200mA (restricted to 150mA below 200V) unit of moderate performance. A regulated variable negative rail from 0 to 85V via a 100K potentiometer and two 6·3V5A centre tapped windings are included. A coarse control varies the output from 0 to 500V in one continuous sweep and a fine control is included. **Price £69–10–0 ex-works**

2V35-25 A very compact unit containing several regulated output voltages. There are two 0 to 350V 250mA sections which may be operated separately, in parallel or in series. Each section has a coarse control to vary the output from 0 to 350V in one sweep and a fine control is included. A fixed 250V 50mA rail and two 6·3V5A centre tapped windings are provided.

Price £175–0–0 ex-works

Model	D.C. Output		A.C. Outputs	Effective Resistance	Voltage Stability	Ripple	Size	Weight	Price ex-Works
	Volts	Current							
M SERIES OPEN CHASSIS UNITS (Mains 200/250V A.C. 115V models available)									
M22	±150V	0-20mA	Nil	0·1 Ω	0·02%	1mV	4¾" × 3¾" × 4¼" ht.	2½ lbs.	£26- 0-0
M22A	±200V	0-20mA	Nil	0·1 Ω	0·02%	1mV	4¾" × 3¾" × 4¼" ht.	2½ lbs.	£26- 0-0
M23	±150V	0-50mA	6·3V2A & 6·3V1A	0·1 Ω	0·02%	1mV	6" × 5½" × 5¾" ht.	6 lbs.	£27-10-0
M23A	±200V	0-50mA	6·3V2A & 6·3V1A	0·1 Ω	0·02%	1mV	6" × 5½" × 5¾" ht.	6 lbs.	£27-10-0
M33	±250V	0-50mA	6·3V2A & 6·3V1A	0·1 Ω	0·02%	1mV	6" × 5½" × 5¾" ht.	6 lbs.	£27-10-0
M33A	±300V	0-50mA	6·3V2A & 6·3V1A	0·1 Ω	0·02%	1mV	6" × 5½" × 5¾" ht.	6 lbs.	£27-10-0
M14A	±100V	0-100mA	2×6·3V3A C.T.	1·0 Ω	0·02%	1mV	10¾" × 7" × 6½" ht.	14½ lbs.	£63- 0-0
M24	±150V	0-100mA	2×6·3V3A C.T.	0·1 Ω	0·02%	1mV	7¼" × 6¾" × 6½" ht.	12¼ lbs.	£33-10-0
M24A	±200V	0-100mA	2×6·3V3A C.T.	0·1 Ω	0·02%	1mV	7¾" × 6¾" × 6½" ht.	12⅝ lbs.	£33-10-0
M34	±250V	0-100mA	2×6·3V3A C.T.	0·1 Ω	0·02%	1mV	7¾" × 6¾" × 6½" ht.	12⅝ lbs.	£33-10-0
M34A	±300V	0-100mA	2×6·3V3A C.T.	0·1 Ω	0·02%	1mV	7¾" × 6¾" × 6½" ht.	12⅝ lbs.	£33-10-0
M25	±150V	0-200mA	2×6·3V3A C.T.	0·1 Ω	0·02%	1mV	8¾" × 8½" × 7" ht.	20 lbs.	£52-10-0
M25A	±200V	0-200mA	2×6·3V3A C.T.	0·1 Ω	0·02%	1mV	8¾" × 8½" × 7" ht.	20 lbs.	£52-10-0
M35	±250V	0-200mA	2×6·3V3A C.T.	0·1 Ω	0·02%	1mV	8¾" × 8½" × 7" ht.	20 lbs.	£52-10-0
M35A	±300V	0-200mA	2×6·3V3A C.T.	0·1 Ω	0·02%	1mV	8¾" × 8½" × 7" ht.	20 lbs.	£52-10-0
M26S	±150V	30-500mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	14" × 11½" × 8" ht.	20 lbs.	£88 0-0
M26SA	±200V	0-500mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	14" × 11½" × 8" ht.	35½ lbs.	£88- 0-0
M36S	±250V	0-500mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	14" × 11½" × 8" ht.	35½ lbs.	£88- 0-0
M36SA	±300V	0-500mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	14" × 11½" × 8" ht.	35½ lbs.	£88- 0-0
M28	±150V	30-350mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	13½" × 8½" × 6½" ht.	29 lbs.	£66- 0-0
M28A	±200V	0-350mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	13½" × 8½" × 6½" ht.	29 lbs.	£66- 0-0
M38	±250V	0-350mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	13½" × 8½" × 6½" ht.	29 lbs.	£66- 0-0
M38A	±300V	0-350mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	13½" × 8½" × 6½" ht.	29 lbs.	£66- 0-0
M SERIES FRONT PANEL UNITS (Mains 200/250V A.C. 115V models available)									
M26	±150V	30-500mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	19" × 12" × 8¾" ht.	46½ lbs.	£ 97-10-0
M26A	±200V	0-500mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	19" × 12" × 8¾" ht.	46½ lbs.	£ 97-10-0
M36	±250V	0-500mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	19" × 12" × 8¾" ht.	46½ lbs.	£ 97-10-0
M36A	±300V	0-500mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	19" × 12" × 8¾" ht.	46½ lbs.	£ 97-10-0
M27	±150V	50mA-1A	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	19" × 15¾" × 8¾" ht.	50½ lbs.	£165- 0-0
M27A	±200V	0-1·0A	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	19" × 15¾" × 8¾" ht.	50½ lbs.	£165- 0-0
M37	±250V	0-1·0A	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	19" × 15¾" × 8¾" ht.	50½ lbs.	£165- 0-0
M37A	±300V	0-1·0A	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	19" × 15¾" × 8¾" ht.	50½ lbs.	£165- 0-0
M29	±150V	100mA-2A	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	19" × 18" × 10½" ht.	82½ lbs.	£255- 0-0
M29A	±200V	0-2·0A	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	19" × 18" × 10½" ht.	82½ lbs.	£255- 0-0
M39	±250V	0-2·0A	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	19" × 18" × 10½" ht.	82½ lbs.	£255- 0-0
M39A	±300V	0-2.0A	2×6·3V5A C.T.	0·1 Ω	0.02%	1mV	5" × 18" × 10½" ht.	82½ lbs.	£255- 0-0
B SERIES RUGGED RELIABLE UNITS (Mains 200/250V A.C. & 100/125V A.C.)									
B101/150	±150V	30-150mA	2×6·3V3A C.T.	0·1 Ω	0·02%	1mV	9¾" × 7⅛" × 6½" ht.	16 lbs.	£55- 0-0
B101/200	±200V	0-150mA	2×6·3V3A C.T.	0·1 Ω	0·02%	1mV	9¾" × 7⅛" × 6½" ht.	16 lbs.	£55- 0-0
B101/250	±250V	0-150mA	2×6·3V3A C.T.	0·1 Ω	0·02%	1mV	9¾" × 7⅛" × 6½" ht.	16 lbs.	£55- 0-0
B101/300	±300V	0-150mA	2×6·3V3A C.T.	0·1 Ω	0·02%	1mV	9¾" × 7⅛" × 6½" ht.	16 lbs.	£55- 0-0
B101/350	±350V	0-100mA	2×6·3V3A C.T.	0·1 Ω	0·02%	1mV	9¾" × 7⅛" × 6½" ht.	16 lbs.	£55- 0-0
B102/150	±150V	30-300mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	14½" × 7⅛" × 6½" ht.	24 lbs.	£75- 0-0
B102/200	±200V	0-300mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	14½" × 7⅛" × 6½" ht.	24 lbs.	£75- 0-0
B102/250	±250V	0-250mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	14½" × 7⅛" × 6½" ht.	24 lbs.	£75- 0-0
B102/300	±300V	0-250mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	14½" × 7⅛" × 6½" ht.	24 lbs.	£75- 0-0
B102/350	±350V	0-200mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	14½" × 7⅛" × 6½" ht.	24 lbs.	£75- 0-0
B103/150	±150V	30-500mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	16½" × 8" × 6½" ht.	32 lbs.	£95- 0-0
B103/200	±200V	0-500mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	16½" × 8" × 6½" ht.	32 lbs.	£95- 0-0
B103/250	±250V	0-500mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	16½" × 8" × 6½" ht.	32 lbs.	£95- 0-0
B103/300	±300V	0-500mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	16½" × 8" × 6½" ht.	32 lbs.	£95- 0-0
B103/350	±350V	0-400mA	2×6·3V5A C.T.	0·1 Ω	0·02%	1mV	16½" × 8" × 6½" ht.	32 lbs.	£95- 0-0

REGULATED POWER SUPPLIES

ROBAND ELECTRONICS LIMITED

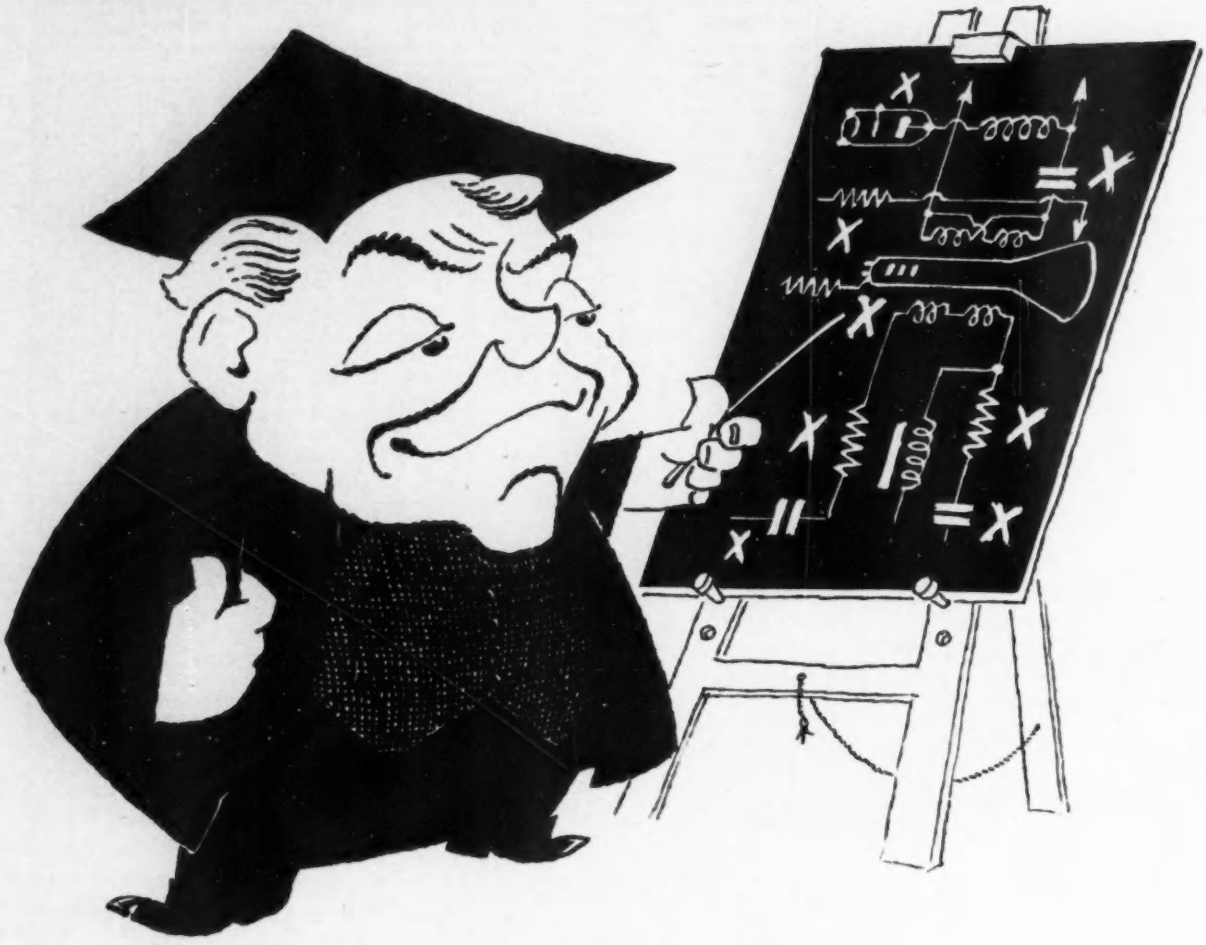
Beulah Works, Beulah Road
Thornton Heath, Surrey

Telephone LIVingstone 6606/7/8

MADE AND GUARANTEED BY

ROBAND

EE 30 032 *for further details*



Wherever

a conductive coating is indicated —

Wherever you need an electrically conductive coating, use one of the Foliac Colloidal Graphite Dispersions. You can spray them or brush them, inside or out, to provide high resistance paths, low resistance paths, capacitor effects, screening or 'earth'. From C.R. tubes and thermionic valves to simple resistor contacts . . . name the use of a conductive coating and the answer is 'Foliac'. If you have a problem involving a conductive film, remember Foliac research is at your service. Why not ask our representative to call?

COLLOIDAL GRAPHITE DISPERSIONS

FOLIAC

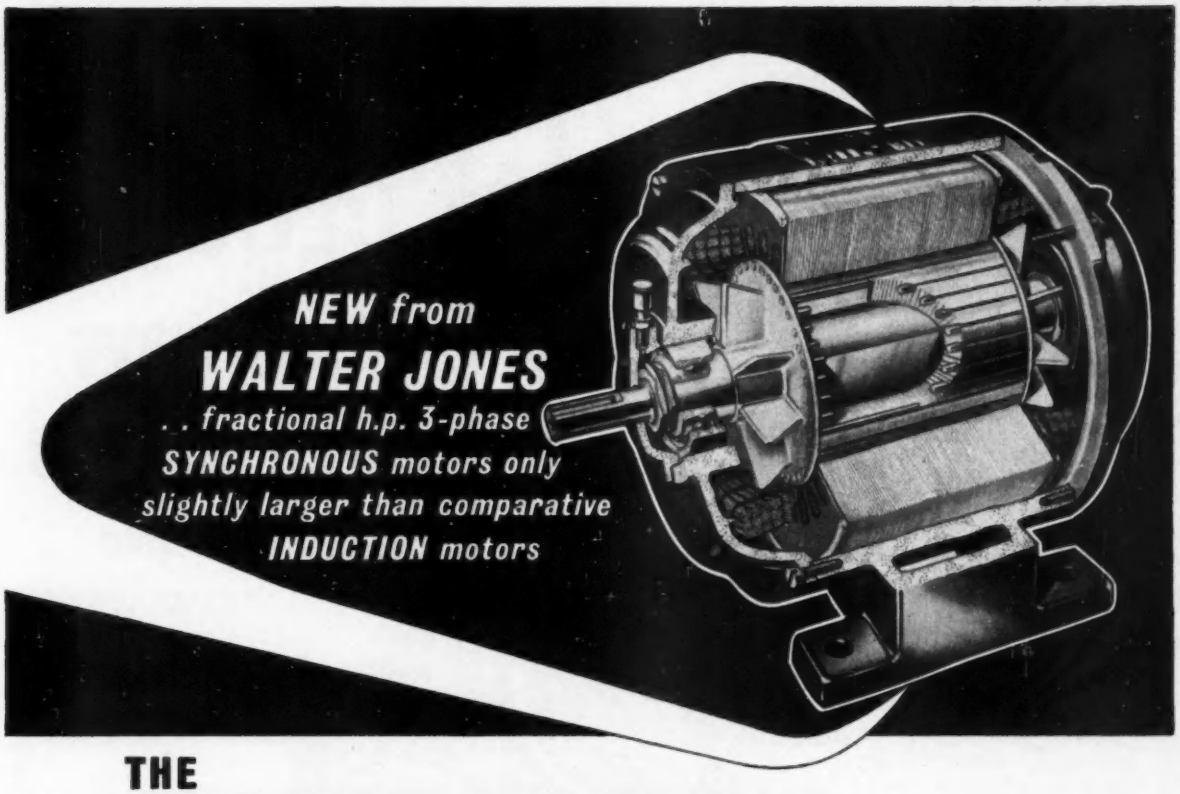
GRAPHITE PRODUCTS LIMITED

ONE OF THE MORGAN CRUCIBLE GROUP OF COMPANIES

NORTHFIELDS · WANDSWORTH PARK · LONDON S.W.18 TELEPHONE: VANDYKE 6422

GP.103/333

EE 30 033 *for further details*



THE PERMINDUCT

3-PHASE SYNCHRONOUS MOTOR

Developed to meet the growing requirement for fractional horsepower, 3-phase, self starting and self-synchronising motors of compact size and enhanced performance, these machines have a higher synchronous output rating for their size than any similar machine of conventional permanent magnet or reluctance designs.

The rotor construction incorporates new technical features. It comprises a central permanently magnetised core around which are assembled annular laminations and copper conductors to form the familiar squirrel cage.

The core utilises a modern high remanence alloy and the improved technical advances of the rotor minimise the de-magnetising effects on starting and synchronising.

PERFORMANCE

Frame size		012	017	N15	N22	M20	M30	L25	L39
50 c.p.s. 2-pole 3000 RPM	HP	·04	·06	·10	·16	·22	·38	·46	·75
50 c.p.s. 4-pole 1500 RPM	HP	·025	·033	·07	·10	·15	·22	·33	·50
400 c.p.s. 4-pole 12,000 RPM	HP	·20	·28	·50	·75				

Manufacturers for over 40 years of small power Electrical rotating equipment.

SEND FOR SPECIFICATION LEAFLETS OF THIS AND OTHER PRODUCTS

WALTER
JONES & COMPANY (ENGINEERS) LTD
CHARLTON WORKS, NEWLANDS PARK, SYDENHAM, LONDON, S.E.26. Telephone SYDenham 6264 - 5 - 6

DECCA
Microwave Instruments

RELIABLE AND CONSISTENT

The range of grade one microwave instruments produced by Decca Radar Limited is continually being improved and augmented. One of the latest additions is a WAVEGUIDE SWITCH of advanced design available in most of the popular waveguide sizes. It is suitable for either hand or mechanical operation.

These efficient modern waveguide switches are of the four port, two channel rotating drum type. Their principal design features are listed on the right.

The 1960 edition of the Decca Microwave and Special Components Catalogue covers microwave instruments, special test equipment, thin film metallised glass elements and gives details of the "Deccaform" copper electroforming component service.

- High adjacent channel isolation from 80 to 100 dB.
- High power handling capacity unpressurised.
- Good match over the whole waveguide frequency band.
- No rubbing contact surfaces.
- Rugged construction.
- Designed for both normal atmospheric and high pressure operation.
- Suitable for hand or mechanical control.

These switches can be manufactured with other switch combinations, for which the company would be pleased to receive enquiries.

DECCA RADAR

Microwave Sales Division
DECCA RADAR LIMITED
DECCA HOUSE · ALBERT EMBANKMENT
LONDON · S.E.11 · Telephone: RELiance 8111

DR 127

SIGNAL GENERATORS in the AUDIO RANGE

by *Advance* to be sure

TYPE H1

The 'Advance' Types H1, J1 and J2 are the most widely used Audio Signal Generators in Great Britain for Research, Development, Communications, Servicing and Education

TYPE H1

Frequency range 15 c/s to 50,000 c/s
Sine or Square Wave output
Output Voltage (High Impedance)
Sine Wave, 200 μV to 20 V, r.m.s.
Square Wave, 800 μV to 80V, peak-to-peak
Distortion less than 1% at 1,000 c/s

Nett Price in U.K. **£30**

Full technical details in leaflet M41

TYPE J1

Frequency range 15 c/s to 50,000 c/s
Output (Sine Wave only)
Into 600 ohms, 0·1 mW to 1 W continuously variable
Into 5 ohms, maximum 0·5 W
Output Impedance
600 ohms, unbalanced
5 ohms, unbalanced (one side earthed)
Distortion, less than 2% at full output

Nett Price in U.K. **£36**

Full technical details in leaflet M33

TYPE J2

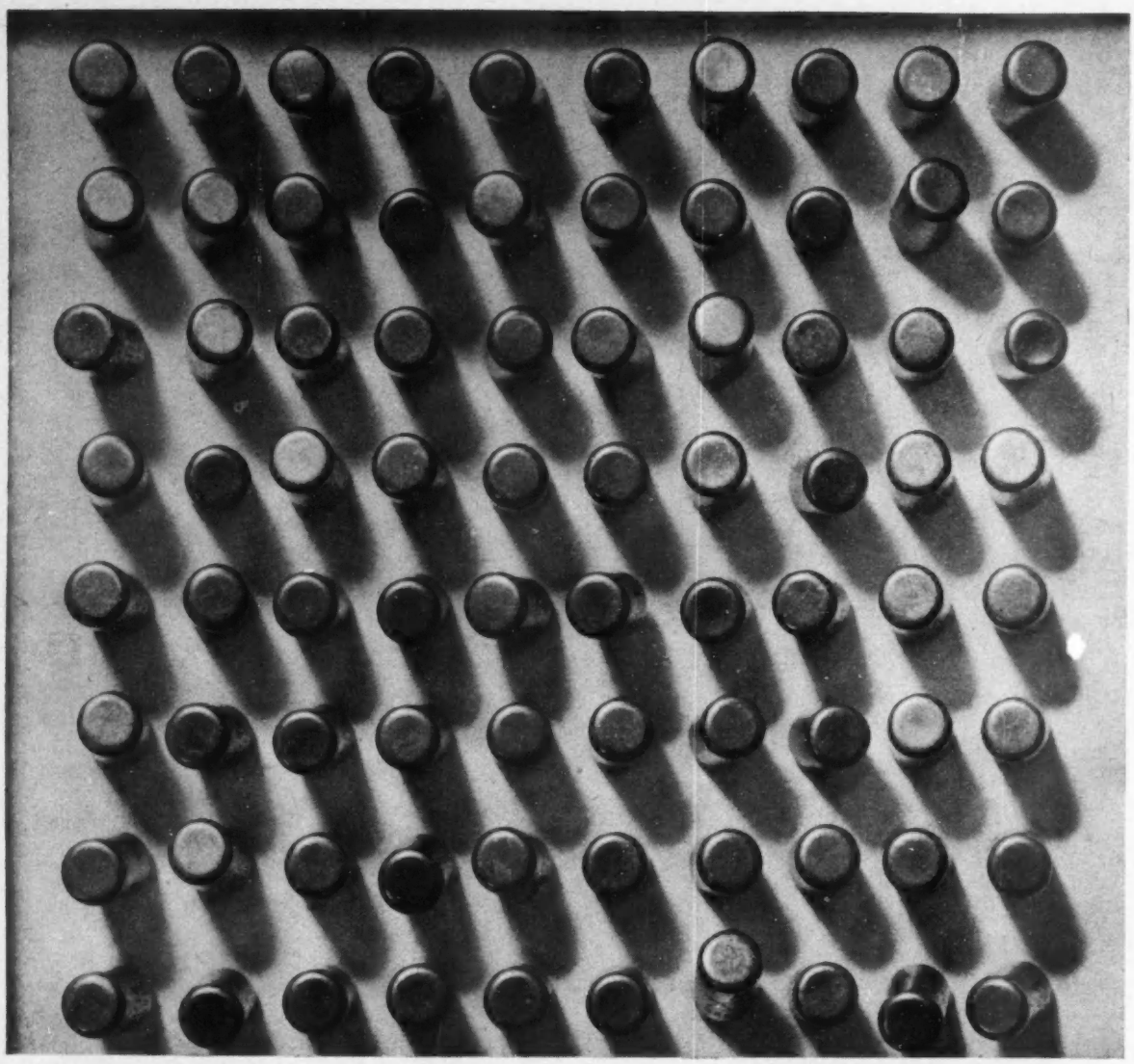
Identical with the Type J1 but with output voltage meter

Nett Price in U.K. **£42**

Full technical details in leaflet MB33

Advance COMPONENTS LIMITED
INSTRUMENTS DIVISION
ROEBUCK ROAD • HAINAULT • ILFORD • ESSEX TELEPHONE : HAINAULT 4444

IT.GD.73



Germanium PNP Alloy Type **TRANSISTORS**

2S26	For Audio Frequency Power Amplification
2S45	For Intermediate Frequency Amplifier Service
2S52	For Converter Service
2SA49	For Intermediate Frequency Amplifier Service
2SA50	For Switching Purpose
2SA52	For Converter Service
2SA53	For Intermediate Frequency Amplifier Service
2SB26	For Audio Frequency Power Amplification
2SB47	Low Noise Factor with Audio Frequency Amplifier
2SB54	For Low Frequency Amplifier Service
2SB56	For Audio Frequency Power Amplifier Service
2SB189	For Medium Power Output Service

Germanium PNP Alloy Type DRIFT TRANSISTORS

2SA57	For High Frequency Amplifier Service
2SA58	For High Frequency Amplifier Service
2SA59	For High Frequency Amplifier Service
2SA60	For Converter Service
2SA92	For Local Oscillator Service
2SA93	For Mixer Services
2SA175	For High Frequency Amplifier Service

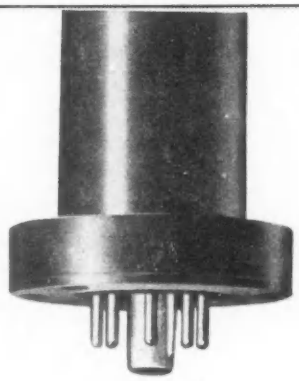
Toshiba

For complete information, write to

TOKYO SHIBAURA ELECTRIC CO., LTD.

2, Ginza Nishi 5-chome, Chuo-ku, Tokyo, Japan

E.I.L ANNOUNCE NEW VIBRON DEVELOPMENTS

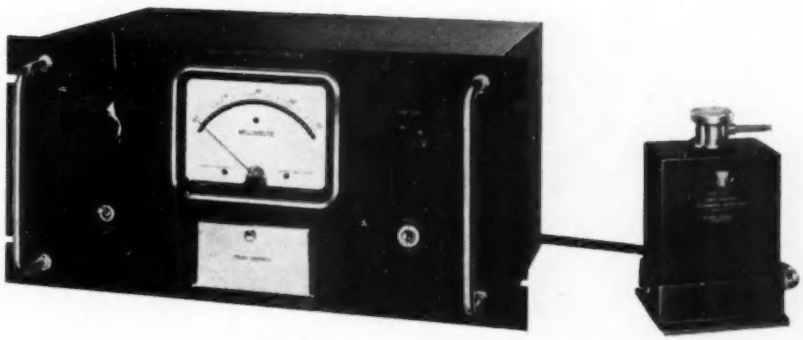


WITH TWO NEW ELECTROMETERS

Two highly versatile instruments which have extended the boundaries of experimental technique in several fields, share at least one feature: both owe their rock-steady zero stability and high input insulation to the E.I.L. VIBRON, a dynamic capacitor of exceptional precision.

The VIBRON MASS SPECTROMETER AMPLIFIER measures the very small beam currents encountered in modern mass spectrometry and discriminates down to 10^{-16} A. Gain is adjustable from 1 to 11,000; by this means the ratio of two mass species can be accurately determined. Its fast response enables the spectrum to be scanned rapidly.

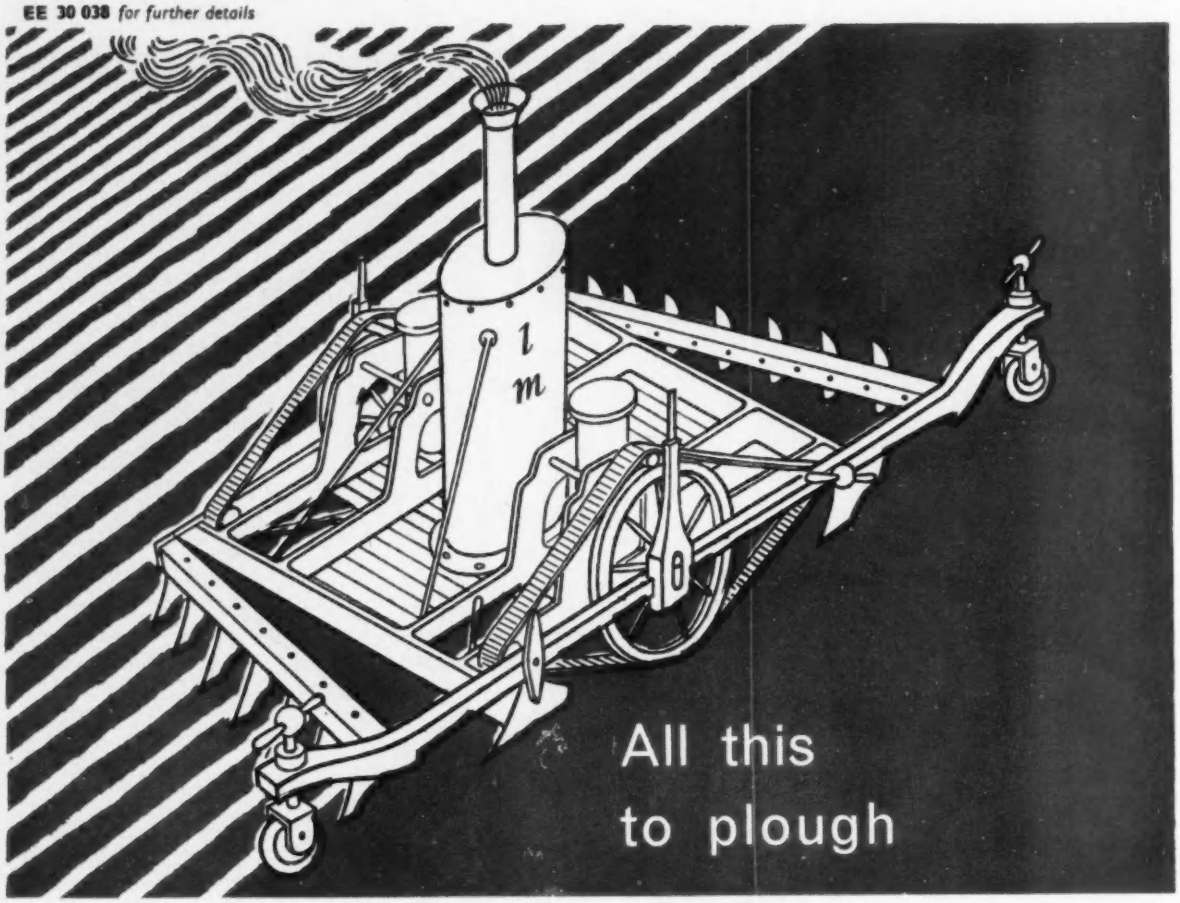
The VIBRON LOGARITHMIC ELECTROMETER is scaled from 0·1 to 1,000 millivolts and measures over these four decades without range switching. Using high value shunt resistors, currents down to 2×10^{-16} A can be detected.



ELECTRONIC INSTRUMENTS LIMITED

RICHMOND · SURREY · ENGLAND · RIChmond 5656

EE 30 038 *for further details*

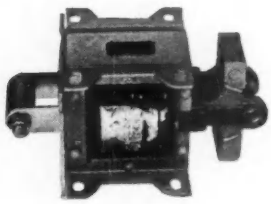


a field

Just imagine this crawling across the fields belching smoke, sparks and noise—but this monster was a great advance in its day—the ancestor of today's powerful and handy tractor. The tractor had to wait until motors and metals were perfected, until technology had caught up with invention.

To-day when the problems are so much more complicated, the solution is often much simpler—contact 'Varley'. If your problem is automatic, remote or push button control; the answer proved many times in many fields is, a 'Varley' Solenoid.

Varley REGD TRADE MARK **solenoids**



The new D Range *(Illustrated)*
has been designed to give greater power, quieter hold for smaller size.

For full details of Varley Solenoids, write for Illustrated Catalogue T1/1

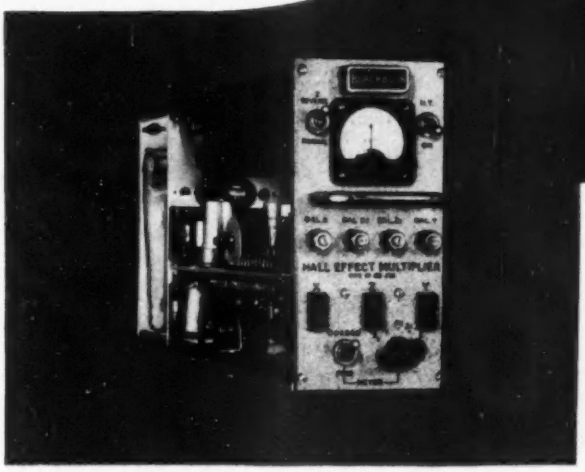
OLIVER PELL CONTROL LTD

Cambridge Row Burrage Road Woolwich SE18

Tel: Woolwich 1422 (5 lines) Telegrams: Olipel London S.E.18

TA3282

Is this your kind of problem? $\sqrt{} \times M = Z$



Hall Multipliers satisfy $\frac{X.Y}{10^3} = Z$ volts

Blackburn Electronics Ltd. have evolved simple and robust Hall-effect multipliers embodying indium-arsenide crystals, with transistorised drift-corrected amplifiers giving ± 10 volts output. Two models are available:

BIE 293 accepts input signals of ± 100 volts peak-to-peak for computer use.
BIE 294 accepts input signals of ± 100 millivolts for instrumentation use.

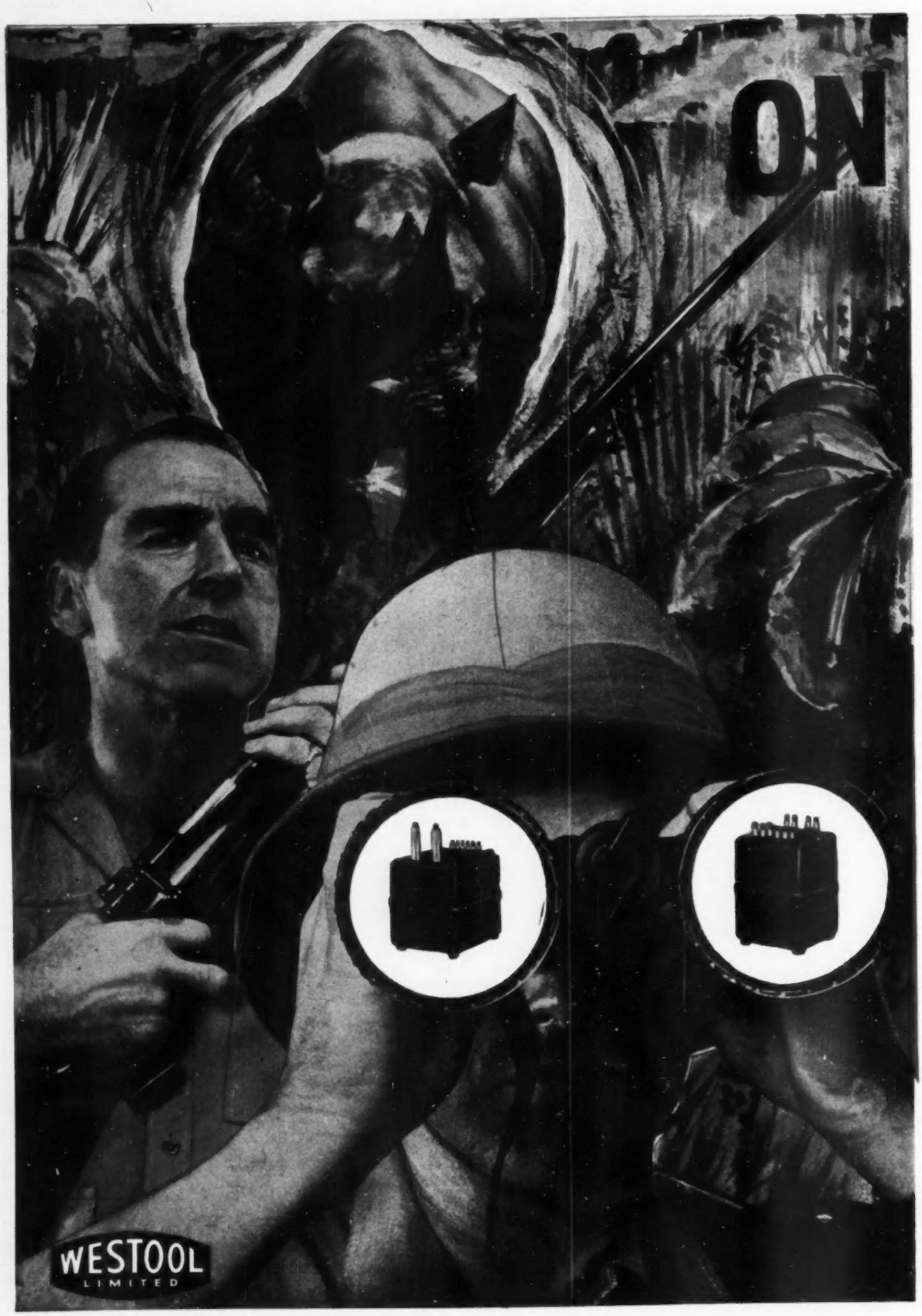
Impedance at the input terminals is one megohm, or 100 kilohms depending on the input voltage. The output amplifiers of both models are capable of driving 100 kilohm loads without clipping or non-linearity. Drift at the output never exceeds 10 millivolts. Band-width extends from DC to 100 c/s.

Over-all accuracy and linearity of both models is better than ± 0·5% of full scale.

Power units producing the + 24 volts DC/-12 volts DC required for these BE Hall multipliers, and capable of driving up to four of either model, are also available from

BLACKBURN ELECTRONICS LIMITED
BROUGH, YORKSHIRE **TELEPHONE: BROUGH 121**

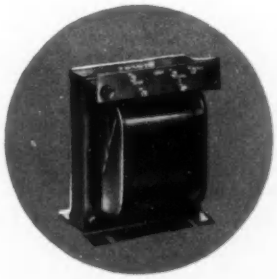
Member Company of the Hawker Siddeley Group

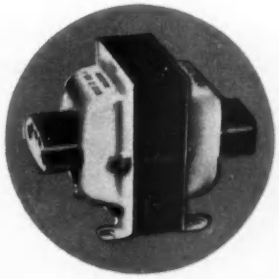

ON
WESTOOL
LIMITED

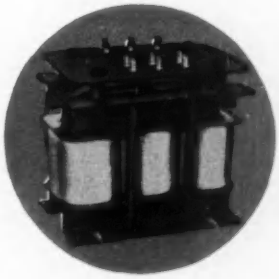
THE TRAIL OF TRANSFORMERS

"Gadsby, you hoary old hunter, you're dead right – it's Westool!
... finest herd of transformers I've seen in twenty years of safari!
I'll bag the open type bunch ... you take the fully shrouded fellows,
and we'll share the encased and hermetically sealed ...
remember they're Westool, they're tough ... stand up to almost anything
... take your time ...!"

Westool transformers from the smallest possible up to 1,500 VA for sealed can types; 5kVA single phase—18kVA three phase. Transformers to BS specifications or to customer's own requirements.







WESTOOL RANGE FAR AND WIDE

WESTOOL LTD., St. Helen's Auckland, Co. Durham
Telephone: West Auckland 551 (6 lines). Telegrams: Solenoids, West Auckland
LONDON: 2, Ashley Place, Carlisle Place, S.W.1. Telephone: Victoria 7301/2
BIRMINGHAM: Silhill House, 2241, Coventry Road, Sheldon, Birmingham, 26
Telephone: Sheldon 5121/2

TIB161

Plessey

TELECOMMUNICATIONS

serve the airways

Plessey is everywhere, you'll find . . . at Beirut Airport for example—and other major airports throughout the world—where radio teleprinter terminals by Plessey form an instantaneous link between control towers for the exchange of vital air traffic control information.

Plessey Telecommunications equipment is employed on a world-wide basis by Civil Aviation Authorities; similarly, it is used internationally by Meteorological Services.

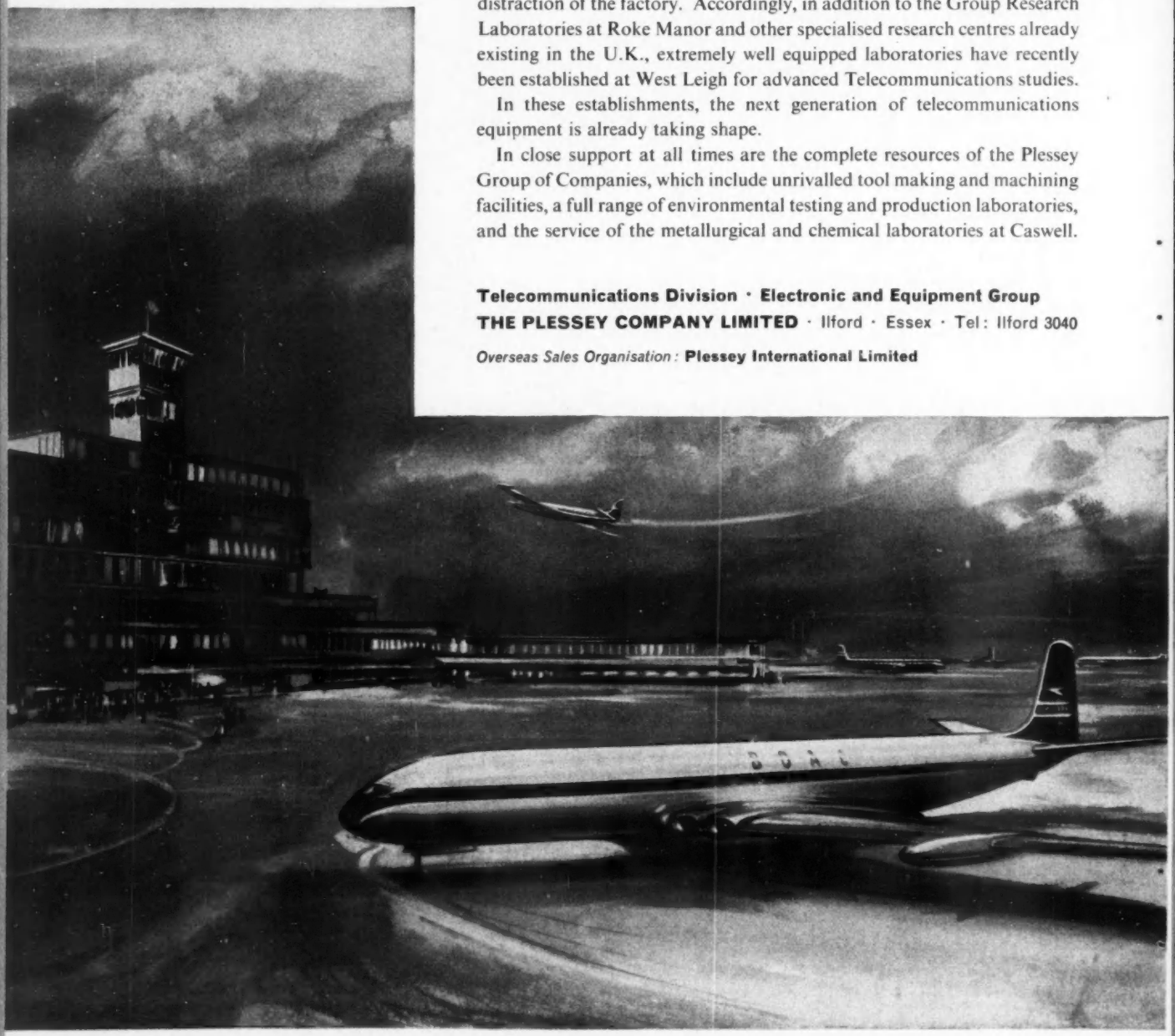
Behind this achievement are the extensive prototype and quality manufacturing resources of the Telecommunications Division, inspired by the work of a unique research and development organisation. The Company recognises the need to segregate advanced thinking from the hustle and distraction of the factory. Accordingly, in addition to the Group Research Laboratories at Roke Manor and other specialised research centres already existing in the U.K., extremely well equipped laboratories have recently been established at West Leigh for advanced Telecommunications studies.

In these establishments, the next generation of telecommunications equipment is already taking shape.

In close support at all times are the complete resources of the Plessey Group of Companies, which include unrivalled tool making and machining facilities, a full range of environmental testing and production laboratories, and the service of the metallurgical and chemical laboratories at Caswell.

Telecommunications Division · Electronic and Equipment Group
THE PLESSEY COMPANY LIMITED · Ilford · Essex · Tel: Ilford 3040

Overseas Sales Organisation: **Plessey International Limited**



SOLARTRON

POWER SUPPLIES

TRANSISTOR POWER SUPPLIES *BENCH UNITS*

TRANSISTOR POWER SUPPLIES *SUB-UNITS*

CHOKELESS POWER SUPPLIES *BENCH UNITS*

CHOKELESS POWER SUPPLIES *SUB-UNITS*

low voltage transistor power supplies

Solartron transistor bench units, built for accuracy and lasting reliability, are ideal for applications requiring highly stabilised low voltage supplies with low source impedance and negligible ripple and noise.
Three decade switches enable a fine 0.1 V step control of the whole voltage range and ensures accurate setting and resetting of the desired voltage.

- *Output voltage adjustable in 0.1 V steps.*
- *Output current monitored on built-in meter.*
- *'Floating' outputs to provide +ve or −ve supplies.*
- *Low output resistance and impedance.*
- *Overload and short circuit protection against accidental misuse.*

UNIT Nos.				
Output Voltage	0—50 V	0—30 V	0—30 V	0—30 V
Current	0—1A	0—3A	0—10A	0—20A
Ripple and noise	< 1 mV pk-pk	< 1 mV pk-pk	< 2 mV pk-pk	< 5 mV pk-pk
Output Resistance	< 0.01 Ω	< 0.01 Ω	< 0.01 Ω	< $*5 \times 10^{-3}$ Ω
Output Impedence (up to 100 Kc/s.)	< 0.35 Ω			
Stability factor ($\frac{\%\ change\ of\ mains\ input}{\%\ change\ of\ DC\ output}$)	> 200:1	> 200:1	> 150:1	> 1000:1
Prices (UK)	£90	£129	£210	

*DC regulation better than 25 mV + 0.25% V_{out}, and particularly suitable for pulse applications.

Mains Input 110/220 V ± 20 V, 50-60 c/s.
Permissible mains variation ± 7% *of nominal.*

SOLARTRON

Write now for full details on the comprehensive range of Solartron Power Supplies.

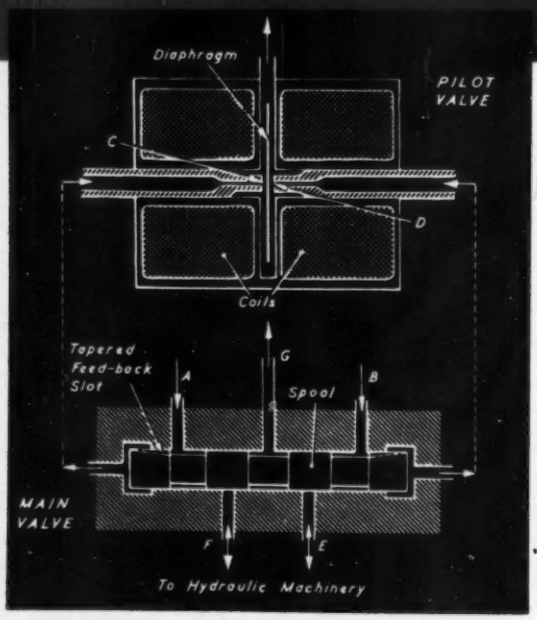
SOLARTRON LABORATORY INSTRUMENTS LTD. Cox Lane, Chessington, Surrey, England.

Telephone: LOWer Hook 2150 · Cables: Solartron Chessington · Telex: 23842 Solartron T.DIT (A member of the Firth Cleveland Group)

EE 30 044 *for further details*

TYPE A·W·E 144/5 ELECTRO-HYDRAULIC SERVO VALVE

This electro-hydraulic servo valve, developed by Armstrong Whitworth from their successful aircraft unit, can be used to control a wide range of hydraulic machinery and is particularly suited to process control systems. The valve utilizes hydraulic rather than electrical power amplifications and has a remarkably high power gain. A diaphragm, clamped around its periphery by two coil housings, is used to control the power — instead of the usual torquemotor — and the valve is therefore not susceptible to vibration effects.



The valve — see diagram — consists of a main valve and a pilot valve. The main valve is supplied with pressure oil through ports A and B. When the spool is in the central position — as shown — the oil escapes through the tapered slots to the opposed jets C and D in the pilot valve and impinges on each side of the diaphragm. The two coils can be energised to attract the diaphragm towards one or other of the jets. If the signal to the right hand coil is the stronger, the diaphragm will flex to the right, restricting the flow from the right hand jet and thus increasing the pressure in that line. Similarly, the pressure in the left hand line is reduced. This pressure difference is transmitted to the main valve and causes the spool to move to the left until the resultant decrease in discharge area of the tapered slot at the right hand end of the spool and the increase in that at the left cause equilibrium to be restored. The displacement of the spool uncovers ports E and F, thus opening pressure and return lines to the hydraulic machinery.

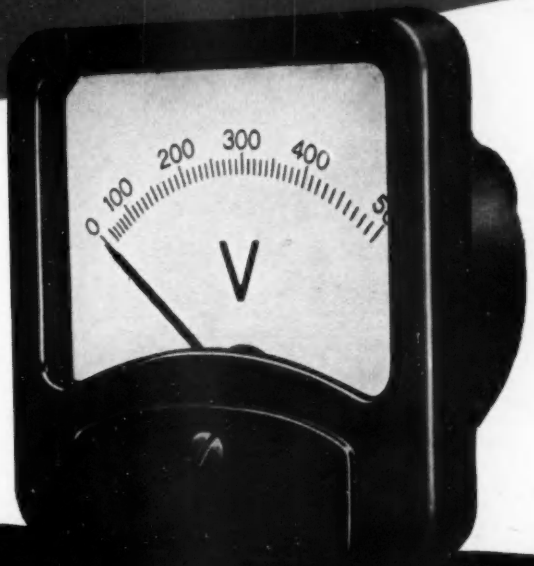
ARMSTRONG WHITWORTH EQUIPMENT HUCCLECOTE, GLOUCESTER · TELE: GLO 67011

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD., A MEMBER OF THE HAWKER SIDDELEY GROUP

EE 30 045 *for further details*

7 CASE TYPES

of flush mounting



MATCHING MINIATURE INSTRUMENTS

for switchboard designers

All 'ENGLISH ELECTRIC' miniature moving iron and moving coil instruments to B.S. 89-1954 can be supplied in the following nominal size cases: 2½ in. and 3½ in. Round Flush; 2 in., 2½ in. and 3½ in. Square Flush; 3 in. x 4 in. and 5 in. x 6 in. Rectangular Flush. Bold open scales give easy, accurate routine readings.

For utmost reliability all 'ENGLISH ELECTRIC' miniature instruments have been designed with a higher-than-normal torque/weight ratio in combination with lower power consumption and have been successfully subjected to:

RESISTANCE TO IMPACT SHOCK TEST of 200g in any plane

VIBRATION FATIGUE TEST—two million cycles at peak resonant frequency

OSCILLATORY TEST—up to one million operations

These non-breathing phenolic moulded cases can be fully sealed to protect the movements from acid-laden atmospheres and comply with specification B.S.2011.H3.

Publications on request to
The English Electric Company Limited,
Instrument Department,
Stafford

'ENGLISH ELECTRIC' instruments

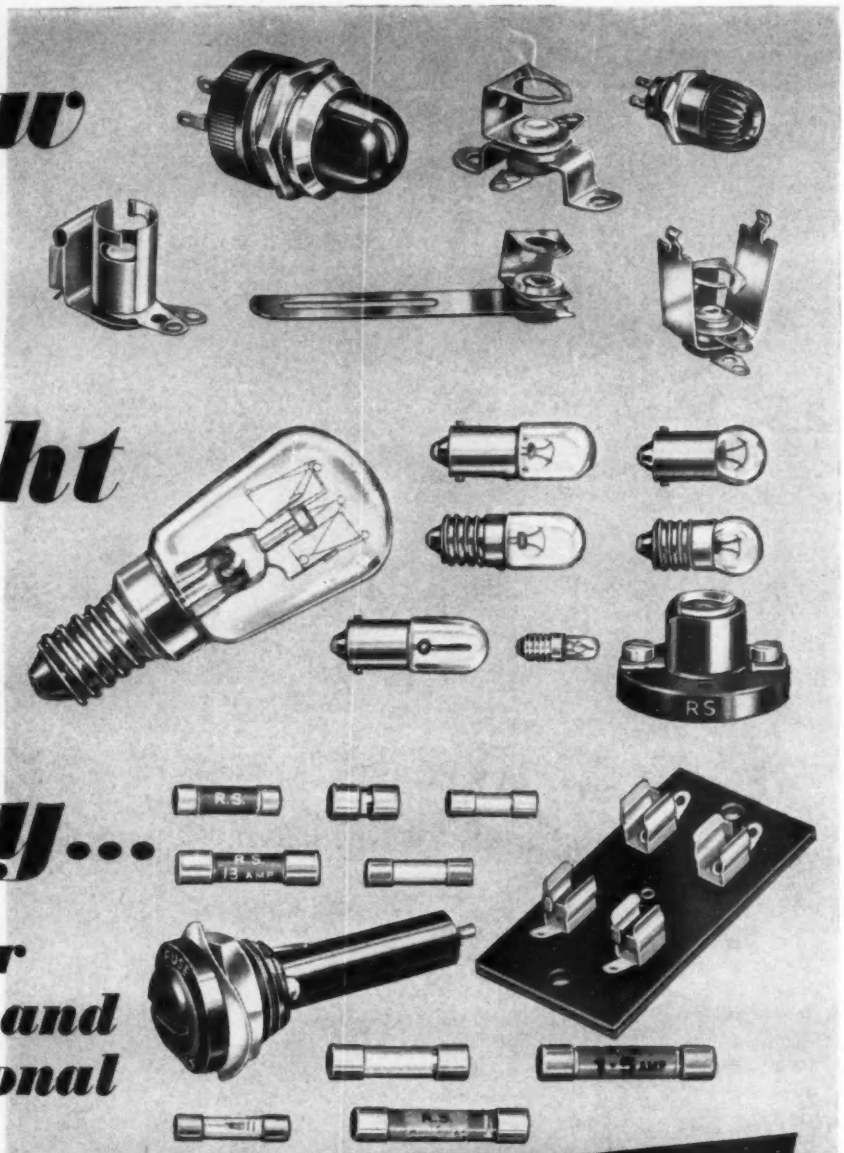
THE ENGLISH ELECTRIC COMPANY LIMITED, ENGLISH ELECTRIC HOUSE, STRAND, LONDON, W.C.2.

WORKS: STAFFORD · PRESTON · RUGBY · BRADFORD · LIVERPOOL · ACCRINGTON

INS.48

EE 30 046 *for further details*

Throw a Light Safely...



on all your prototype and constructional problems

Use RADIOSPARES Quality Components

'BY RETURN' DELIVERY SERVICE OF GUARANTEED ELECTRONIC COMPONENTS

Consult our catalogue for all types of Pilot Lamps, Lamp Holders, Fuses and Fuseholders

Radiospares Ltd.

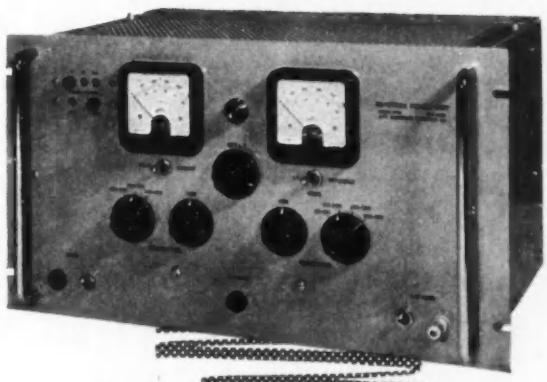
4-8 MAPLE STREET · LONDON · WI · ENGLAND

Telephone: EUSton 7232-9

TELEGRAMS: RADOSPERES, WESDO, LONDON *CABLES:* RADOSPERES, LONDON

EE 30 047 *for further details*

STABILISED POWER SUPPLIES



MODEL 2763
LOW VOLTAGE KLYSTRON SUPPLY
Resonator Supply 250 V — 400 V. 0-50 mA.
Reflector Supply 50 V — 400 V. 0-50 microamps.
L.T. Supply 5.5 V — 6.5 V. D.C. 0-1 Amp.
Aux. Supply for associated circuitry 400 V. 0-20 mA.
Stability better than 0.2% on H.T. lines for input variations ±10%.
Ripple less than 2 mV R.M.S.
PRICE £155 ex-works.

MODEL 508
0 — 500 V. D.C. 350 mA.
6.3 V. 10 Amps. A.C.
Neg. 250 V. 25 mA.
Stability of D.C. Outputs better than ±0.1% for input variations ±10%, and no load to full load current.
Ripple less than 3 mV R.M.S.
PRICE £98 ex-works.

MODEL 3798
0 — 50 V. D.C. 100 mA.
6.3 V. 5 Amps. A.C.
Maximum variation of D.C. Output Voltage less than 50 mV for input variations ±10%, and no load to full load current.
Ripple less than 1 mV R.M.S.
PRICE £60 ex-works.

ELECTRONIC INDUSTRIES LIMITED

CHERTSEY ROAD
BYFLEET · SURREY

PHONE BYFLEET 4131/2/3/4
GRAMS APTRAN BYFLEET

CLUTCH *in the palm of your hand!*

This versatile miniature magnetic instrument clutch is just one CROFTS contribution to the ever growing fields of light engineering and instrumentation. Versatile, because it can be used as clutch/coupling, clutch/brake or duplex clutch; and so miniature it sits right in the palm of your hand.

Inching, load locking, shaft positioning, high-speed motor reversal, speed synchronising—there's no end to its applications!

The standard range covers five sizes, transmitting torques from 4.2 to 420 oz. ins. at any normal speed. A range of positive-engagement clutches operating at similar speeds is available to transmit torques from 14 to 1400 oz. ins.

For full operating data, technical information and physical details of CROFTS instrument clutches—send for Publication 6013A.

Crofts

CROFTS (ENGINEERS) LIMITED

POWER TRANSMISSION ENGINEERS

THORNBURY · BRADFORD 3 · YORKSHIRE

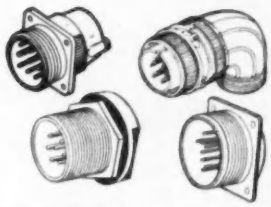
Telephone: 65251 (20 lines) Telegrams: 'Crofters Bradford Telex' Telex: 51186

BRANCH OFFICES: London, Belfast, Birmingham, Bristol, Cardiff, Dublin, Glasgow, Ipswich, Leeds, Liverpool, Manchester, Newcastle Northampton, Nottingham, Sheffield, Stoke-on-Trent

ELECTRICAL CONNECTORS
(PLUGS AND SOCKETS)

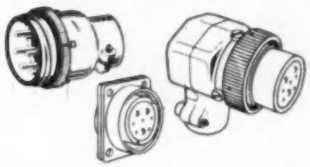
for EVERY conceivable application

AIRCRAFT ENGINE, INSTRUMENTATION, INDUSTRIAL AND GENERAL ELECTRONICS APPLICATIONS—THE MS SERIES CONFORMING TO MIL-C-5015D



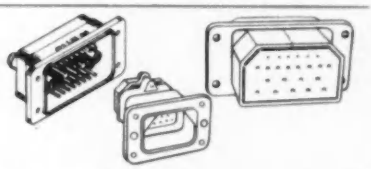
The MS and MS related series can provide connectors with the following characteristics:— High-temperature, vibration-proof, lightweight, environmental, radiation-resistant, potting, bulkhead, hermetically sealed, splashproof, waterproof. They are available with from 1 to 100 contacts, 15 different insert diameters from ¼" to 2¼", over 250 contact layouts, 6 shell styles, current rating from 10 to 200 amps, working voltages from 200 to 50,000 volts AC. Contacts are precision machined from high quality copper, silver plated to ensure low contact resistance. All other components are manufactured to extremely high precision standards and provide the utmost in reliability.

GENERAL CIRCUITRY AND INDUSTRIAL APPLICATIONS—THE K AND RK SERIES



A general purpose, rugged durable range, offering:— Acme coarse thread coupling; conduit or cable clamp entry, lightweight construction. Available with from 1 to 110 contacts, including coaxials, in eight different insert diameters from ½" to 2¼". There are 7 basic shell styles accommodating more than 220 insert arrangements with current ratings of from 10 to 200 amps and a variety of voltage capacities. Contacts are brass, silver plated; Insulators of high quality phenolic, melamine or formica. Shells are cadmium plated aluminium alloy. Hermetically sealed types available with steel shells. An audio/video series is available in this range.

UNIT-PLUG-IN RACK/PANEL APPLICATIONS:—THE D AND DP SERIES

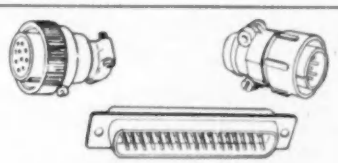


This rectangular range of connectors permit rapid disconnection, interchange, replacement, testing and inspection of assemblies and sub-assemblies. Designed for "rack and panel" applications, both mating halves can be rigidly mounted, or one can be cord connected if required. There is a vast range available including hermetically sealed, pressurised and environmental types. 2 to 224 contacts can be provided in rectangular inserts ranging in size from $\frac{5}{8}$" x $\frac{13}{16}$" up to 2¾" x 4¼", with a great variety of current and voltage ratings.

AUDIO/VIDEO AND LOW LEVEL CIRCUIT APPLICATIONS

Six different ranges are available which can primarily be identified by their latch-lock coupling mechanism, a device which permits rapid positive engagement whilst preventing accidental disconnection of trailing cables. Rugged cylindrical shells permit use under arduous service conditions. 1 to 18 contacts, with current ratings from 10 to 30 amps are provided in insert diameters 1" or smaller.

MINIATURE AND SUBMINIATURE SERIES

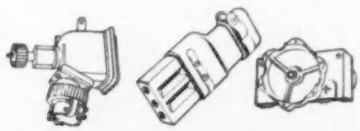


These ranges of connectors are already extensive but are continually expanding due to current weight-space limitations of modern flight. Designed for amplifiers, miniature indicators, computor circuits, telemetering equipment and general instrumentation. The majority of contacts are 5 amp, gold plated copper. From 3 to contacts 54 are obtainable with miniature coaxials in some series. Rectangular or circular types. *Maximum* insert sizes are $\frac{13}{16}$" x 1$\frac{7}{16}$" for rectangular series and 1" diameter for circular. Hermetically sealed and environmental types available.

RADIO FREQUENCY COAXIAL SERIES

Available in a wide range of Series and types including subminiatures, MB-SM, HN, N, BNC. The latest development is the new aluminium series of R.F. connectors and adapters designed for use with semi-flexible aluminium sheathed cables, where weight saving is a critical design criteria. Currently available are types TNC, N, C, SC, LT and LC plugs and jacks.

OTHER SERIES AND APPLICATIONS



Cannon Electric International Inc. also has available connectors for the following applications:— Guided Missile Launching, Battery and Power Supply, Laboratory and Switchboard, Printed Circuit, Manometer air line, Buffet and Aircraft Galley. In addition there are comprehensive ranges of AC and DC Solenoids, and "Kwik-Term" Subminiature, feed-through and stand-off terminals. A brand new development is the "Morpho"—a multi-pin, modular connector of hermaphrodite construction. Has crimp contacts. Is ideally suitable for commercial applications where space, ease of wiring and neat external appearance are critical factors.

For additional information on any of the series referred to above or if you have any specific connector problems write, quoting EE to:—

CANNON ELECTRIC INTERNATIONAL INC.

168/172 Old Street, London, E.C.1. Telephone: CLErkenwell 4954 (6 lines) *or, for all European requirements to:*— 79 Boom Straat, Bornem, Belgium. Telephone: Antwerp 770614

Largest facility in the world for
PLUG
RESEARCH · DEVELOPMENT
MANUFACTURE

EE 30 050 *for further details*

JR

NICKEL SILVER AND CUPRO-NICKEL

For Electronics, Radio & Telecommunication Fields . . . . . .

NICKEL SILVER All qualities from 5% Nicke content to 30% Nickel content.

CUPRO-NICKEL All qualities from 5% Nickel content to 45% Nickel content.

SHEET Maximum width 24". Minimum thickness 0·006".
STRIP Maximum width 18". Minimum width ⅛", Minimum thickness 0·005".
WIRE Maximum diameter ⅛". Minimum diameter 0·0025"

Specialities High finish Nickel-Silver Telephone Strip and Sheet conforming to BSS 1824, or to your own specifications for the manufacture of Spring contacts, Relay blades, etc.

We also specialise in producing Copper-Nicke lAlloys (Cupro Nickel) with special resistance properties in the form of Sheet, Strip and Wire.

Established 1845

JONES AND ROOKE

JONES & ROOKE (1948) LTD. NORTHWOOD STREET ROLLING MILLS, BIRMINGHAM 3.

3 into 1 will go —

and produce a low-priced

BE Digital Recorder (BIE2814)

This portable Digital Recorder comprises the well-proved B E 50-channel Scanning Switch, Digital Voltmeter and the H P Strip Printer.

The unit may be operated at a scanning rate of 1 or 3 channels per second in any one of 3 modes: continuous scanning of all selected channels: single scan of all selected channels: continuous sampling of 1 selected channel. Channels may be selected for scanning in groups of 10. The Voltmeter incorporates 3 automatically selected ranges from 0 to ± 999·9 volts with an accuracy of 0·05% of full scale on any range.

Print-out comprises channel identification, voltage magnitude, polarity and decimal point.

For further information please write to:

BE BLACKBURN ELECTRONICS LIMITED
BROUGH YORKSHIRE TELEPHONE BROUGH 121
Member Company of the Hawker Siddeley Group

EE 30 052 *for further details*

OC200
OC200
OC200
OC200
OC200

SILICON CHARACTERISTICS AT GERMANIUM PRICE

*** now costs less than any other silicon alloy transistor**
*** now even cheaper than many germanium types**

SO NOW you can specify a quality silicon alloy transistor — in most of those instances where previously silicon semiconductors were considered too costly. What's more, there are no delivery problems. Thanks to Mullard large scale production, the OC200 is available for immediate delivery in quantity.
Already, of course, the OC200 has proved its worth in practical applications. Low bottoming voltage . . . low noise figure . . . unusually wide temperature range. The OC200 has all the attributes you could wish for in a general purpose transistor. It is suitable for use at low and high temperatures in switchgear and a wide variety of industrial equipment. And now that price is no problem — the scope of the OC200 grows wider still. If you would like further details simply write to the address below.

Minimum operating ambient temperature	(°C)	− 50
Maximum junction temperature	(°C)	+ 150
Abridged data (at Tambient 25°C)		
V_{cb} max.	(V)	− 25
V_{ce} (cut-off) max.	(V)	− 25
V_{ce} (I_c=50mA) max.	(V)	− 20
I_c (pk) max.	(mA)	50
I_c max.	(mA)	50
α^1 (f=1kc/s) spread		15 to 60
V_{ce} (I_c=7mA, I_b=1mA)	(mV)	− 130
$r_{bb}{}^1$ (V_{ce}= −6V, I_c=1mA)	(Ω)	125

Mullard

semiconductors
for industry

MULLARD LIMITED
Semiconductor Division
Mullard House · Torrington Place
London WC1 · Tel: LANgham 6633

Mullard

MIS 28

EE 30 053 *for further details*

Series 100

For fast accurate counting

You can't do better than to specify this Series 100 instrument. Tooled to the finest limits, together with a highly efficient magnetic circuit, it offers a long life, with extreme accuracy, at fast counting speeds. Figures are large and readable with perfect alignment; the whole counter carries the superb finish for which all C.I. products are famous. Designed for flush panel mounting, number of figures—6.

High speed

quick reset

electro-magnetic

counter

push button

or electrical

reset

Mechanism is the heart-shaped type, and accidental resetting when the counter is running does not harm the mechanism.

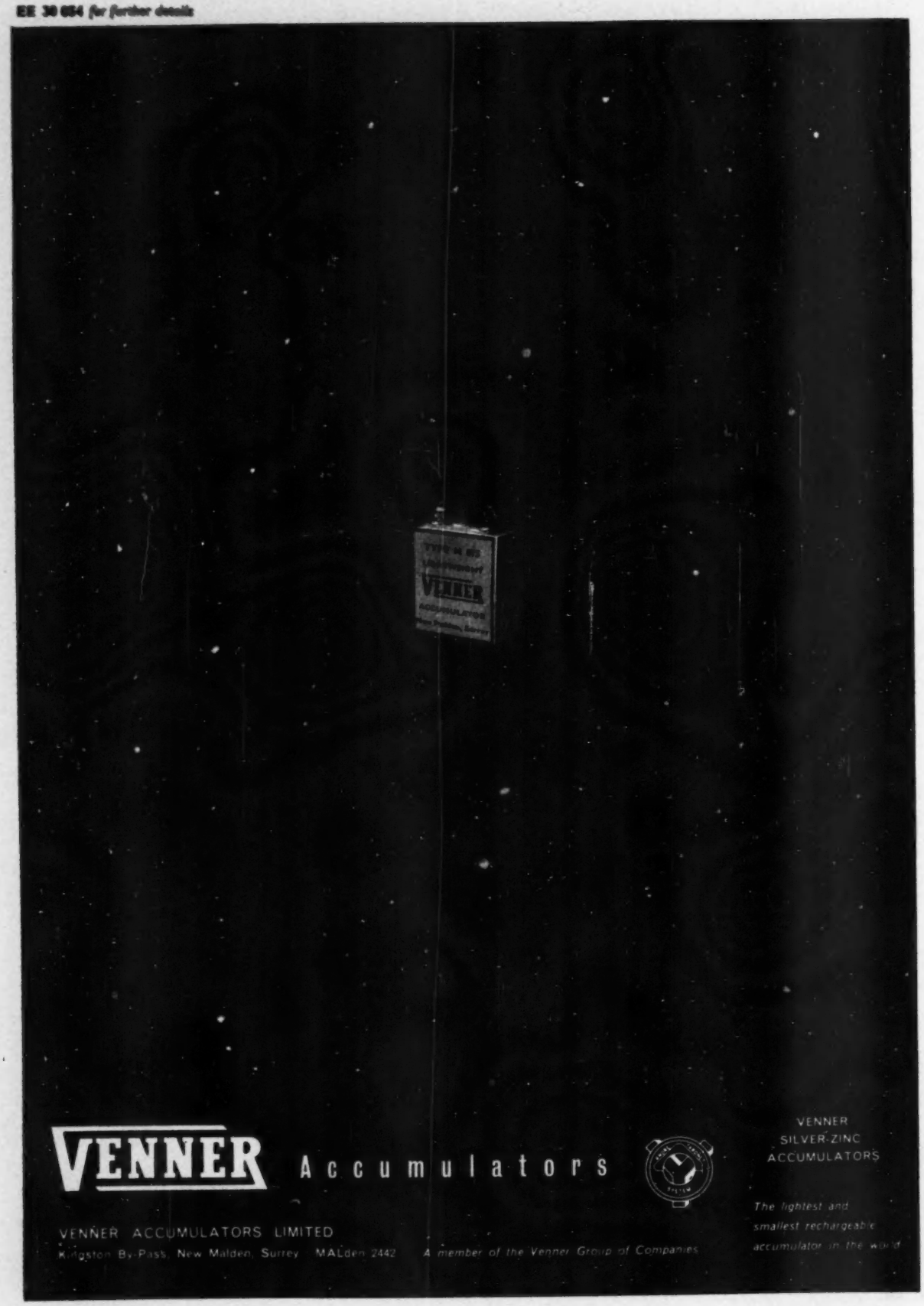
OPERATING VOLTAGE	24 or 48 volts D.C. 110/115 volts A.C. 50 or 60 cycles. 200/250 volts A.C. 50 cycles.
POWER CONSUMPTION	4 watts. Coils continuously rated.
OPERATING SPEED	At least 20 counts per second.
RESET	Push button or Electric.
NUMBER OF FIGURES	6
FIGURES	White. 7/32" high (5.4mm) on black ¼" dia. wheels.
CASE	Die cast case with aluminium side plates. Finish matt black.
LEADS	12" Trailing.

Also available as a dozens counter with first wheel graduated 0 to 11.

Counting Instruments Ltd. Elstree Way, Boreham Wood, Hertfordshire, England.
Telephone: ELStree 1382

wh

EE 30 654 for further details



"Twitterton! Is this really FORMICA*?"

Yes, this is a printed circuit made from a FORMICA copper-clad laminate. It is used in the newest type of telephone, beautifully made by The Plessey Company Limited to G.P.O. specifications. And it's just one of many Formica products.

Not so long ago, the name Formica was associated with decorative laminates, used mainly in kitchens and canteens. Today, among many other activities, Formica Ltd. with their industrial laminates make a valuable contribution to quick and reliable telecommunications. And in today's world you'll frequently come across most of the other Formica products listed below.

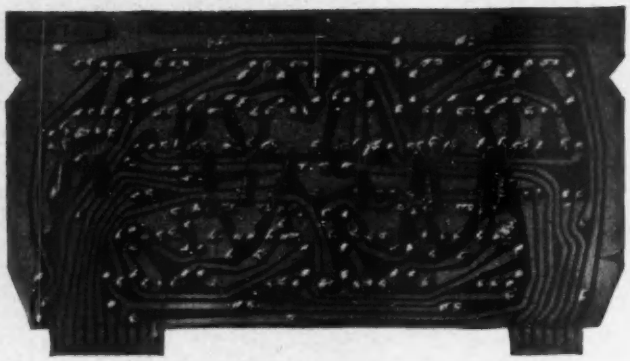
FORMICA make

CHAIR SETS
DECORATIVE LAMINATES
INDUSTRIAL LAMINATES
EXTRUDED PLASTICS

For full information on any FORMICA product, please write to:
FORMICA LIMITED, De La Rue House, 84-86 Regent Street, London, W.1 Tel: REGent 8020
* FORMICA *is a registered trade mark.*

EE 30 056 *for further details*

Printed Circuit Counter Panels



A complete range of transistorized counter panels of common size, fixing method and electrical connexion, designed to provide a flexible unit system whereby any special requirements in the counting or data processing fields can be quickly built up.

A fully illustrated brochure giving complete performance and specification figures for every panel in the range is available on request.

50kc/s Scaler
1Mc/s Scaler
Input Amplifier
Gate Unit
10kc/s Oscillator
1Mc/s Oscillator
Power Unit
50kc/s Read-out Scaler
1Mc/s Read-out Scaler
4 Channel Output Unit
Read-out Unit
Meter Display Unit
Lamp Display Unit
Numerical Indicator Tube
Shift Register Stage
Shift Register Driver

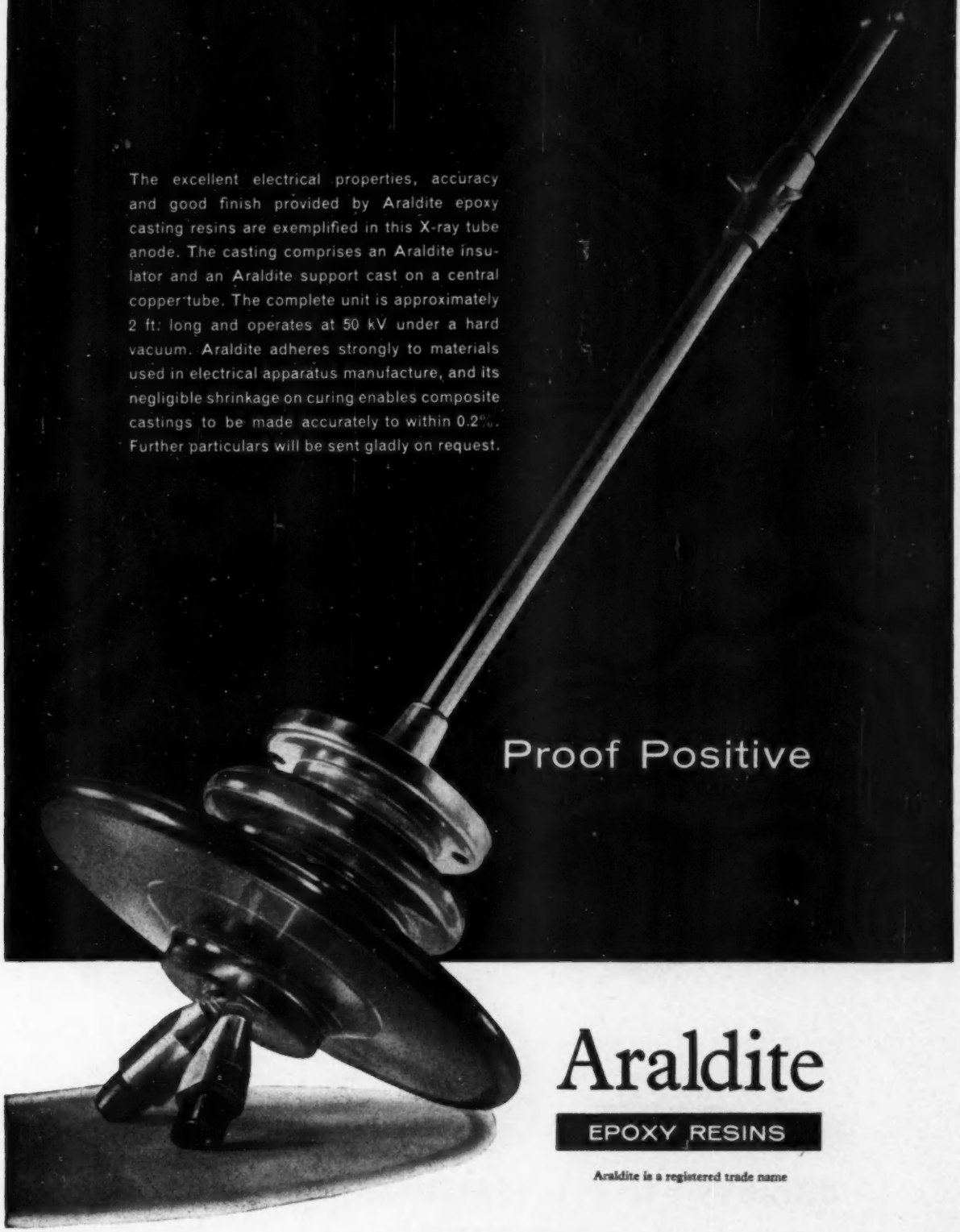
CINTEL INSTRUMENT Division

RANK CINTEL LIMITED
Worsley Bridge Road · London · SE 26
HIther Green 4600

Sales and Servicing Agents: Atkins, Robertson & Whiteford Ltd., Industrial Estate, Thornliebank, Glasgow; McKellen Automation Ltd., 122 Seymour Grove, Old Trafford, Manchester, 16; Hawnt & Co. Ltd., 112/114 Pritchett Street, Birmingham, 6

EE 30 057 *for further details*

The excellent electrical properties, accuracy and good finish provided by Araldite epoxy casting resins are exemplified in this X-ray tube anode. The casting comprises an Araldite insulator and an Araldite support cast on a central copper tube. The complete unit is approximately 2 ft. long and operates at 50 kV under a hard vacuum. Araldite adheres strongly to materials used in electrical apparatus manufacture, and its negligible shrinkage on curing enables composite castings to be made accurately to within 0.2%. Further particulars will be sent gladly on request.



Proof Positive

Araldite

EPOXY RESINS

Araldite is a registered trade name

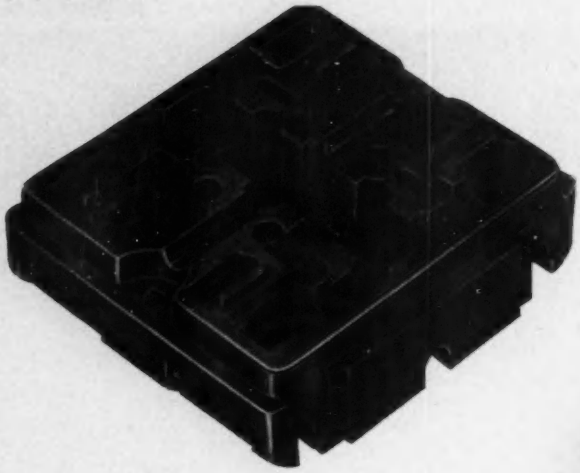
Casting by McKinlay Electrical Mfg. Co. Ltd. for Hilger & Watts Ltd.

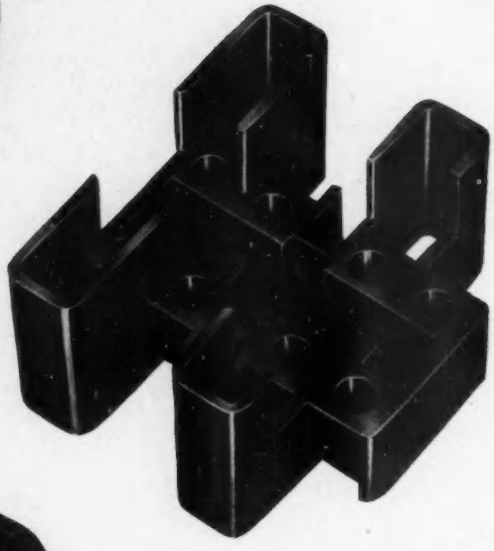
CIBA (A.R.L.) LIMITED

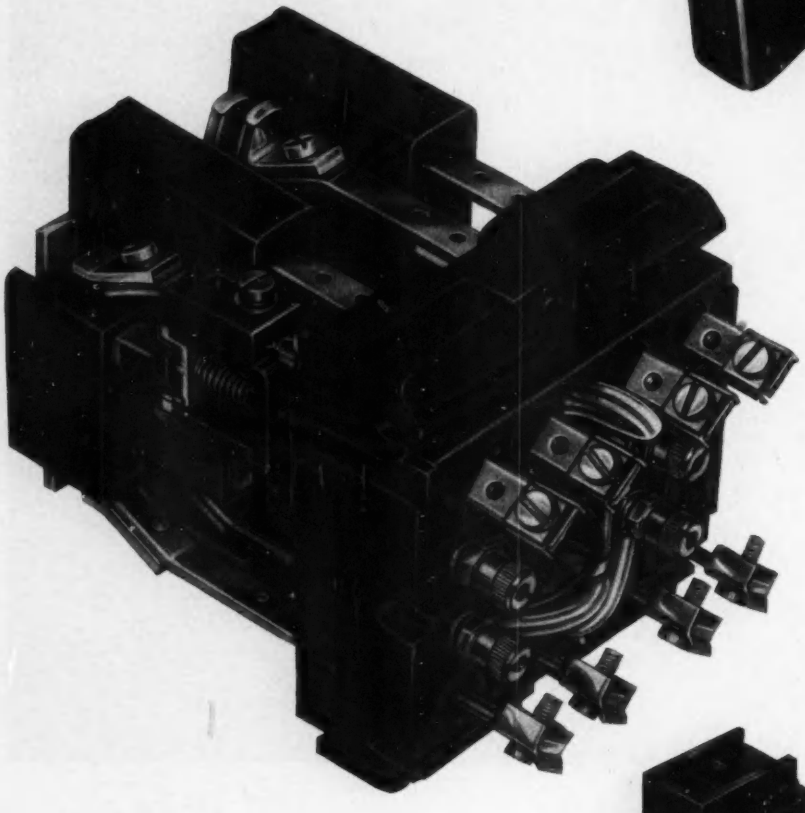
Duxford, Cambridge. Tel: Sawston 2121

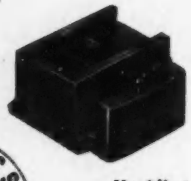
AP 585

EE 30 058 *for further details*









These Base, Bridge, Contact and Bobbin Mouldings are made by us for British Klockner Switchgear Ltd., and used in Contactor illustrated. They are produced in our ELO S.O.1 Phenolic moulding material

Compression Transfer and Injection Mouldings

PLASTICS ELO PRODUCTS

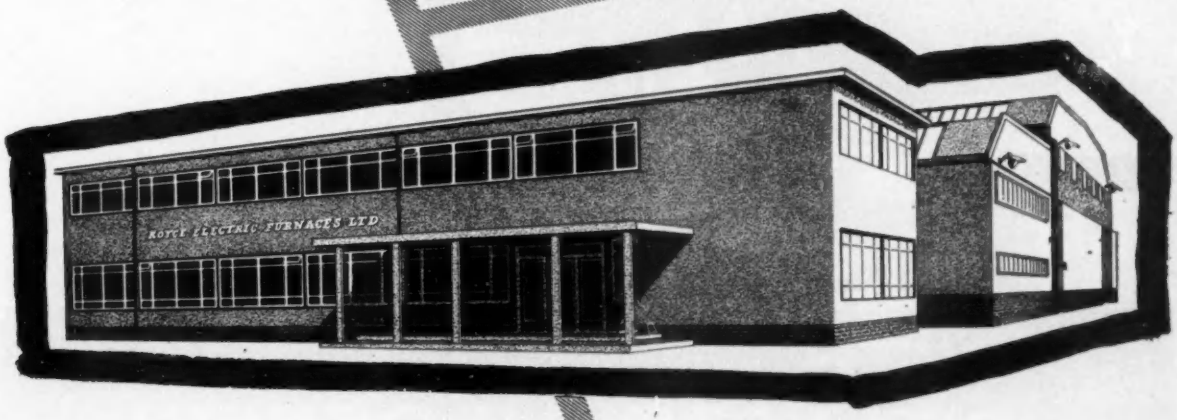
Moulding Materials Resins, Varnishes Cements and Lacquers

BIRKBYS LTD · LIVERSEDGE · YORKSHIRE

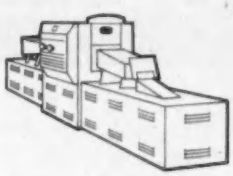
Telephone Heckmondwike 514

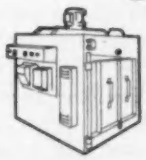
London Office: 79 BAKER STREET, W.1. WELbeck 5746

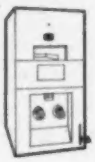
a new home for **ROYCE 'SPECIALS'**



ROYCE furnaces specially designed for your requirements cost no more than standard plant







This new, well equipped factory at Sheerwater, Surrey, is a fitting home for Royce Electric Furnaces—a stable worthy of the thoroughbreds it produces!

Now more than ever you should specify a Royce furnace. Choose from the comprehensive range of Royce Standards or have a Royce 'Special'—a furnace designed for *you* to meet *your* requirements.

For your new furnace get a quotation from Royce.

ROYCE ELECTRIC FURNACES LIMITED

ALBERT DRIVE SHEERWATER WOKING SURREY *Telephone: Woking 5401-4*

EE 30 060 *for further details*

DOWN WITH DIELECTRIC LOSSES!

SILICONE RESIN-BONDED GLASSCLOTH LAMINATES have excellent dielectric properties over a wide frequency range, low water absorption, excellent arc resistance and thermal endurance that permits operation up to 250°C.

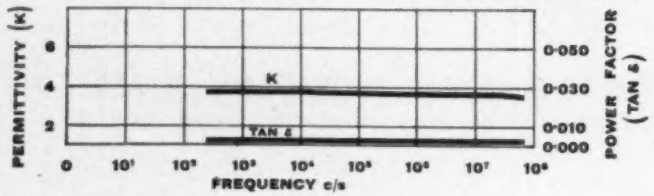
An important feature of these laminates is that they retain high insulation resistance under humidity cycling.

Silicone-glass laminates are made as flat sheets, as tubes and in a variety of shapes. They can be machined without difficulty provided tungsten carbide tools are used and the cutting edges are kept very sharp. They may also be cut with abrasive disc machines.

Applications include: printed circuits, coil formers and as supporting or separating materials in all kinds of electrical and electronic equipment.

Typical Properties of Silicone-Glass Laminates

Specific gravity	1·8
Tensile strength, lb/sq in	15,000–30,000
Flexural strength, lb/sq in	30,000–50,000
Water absorption after 24 hrs immersion, %	0·07–0·02
Power factor at 10^6c/s	0·001–0·003
Permittivity, at 10^6c/s	3·6–4·2
Electric strength ¼" thick, V/mil	200–500



The properties and applications of silicone-glass laminates are dealt with more fully in our booklet L18 — please write for a copy.

MS

MIDLAND SILICONES LTD

(Associated with Albright & Wilson Ltd. and Dow Corning Corporation)

***first** in British Silicones*

68 KNIGHTSBRIDGE · LONDON · SW1

TELEPHONE : KNIGHTSBRIDGE 7801

Area Sales Offices: Birmingham, Glasgow, Leeds, London, Manchester
Agents in many countries

MSE11

'ENGLISH ELECTRIC' STORAGE TUBES

FIRST AGAIN IN BRITAIN

The English Electric Valve Co., consistent with their policy of keeping in the forefront with new electronic devices, have recently enlarged considerably their Storage Tube Division. Increased facilities and effort are being applied to the development and production of a number of Storage/Memory Tubes, two of which are illustrated, and enquiries are invited for special types to meet individual requirements.

E702 Direct-view Storage Tube has a useful screen diameter of 4 inches and information can be displayed at high brilliance (2350 foot-lamberts) for one or two minutes. The persistence can be controlled for 10 minutes or more, or the display can be completely erased in 300 milliseconds.

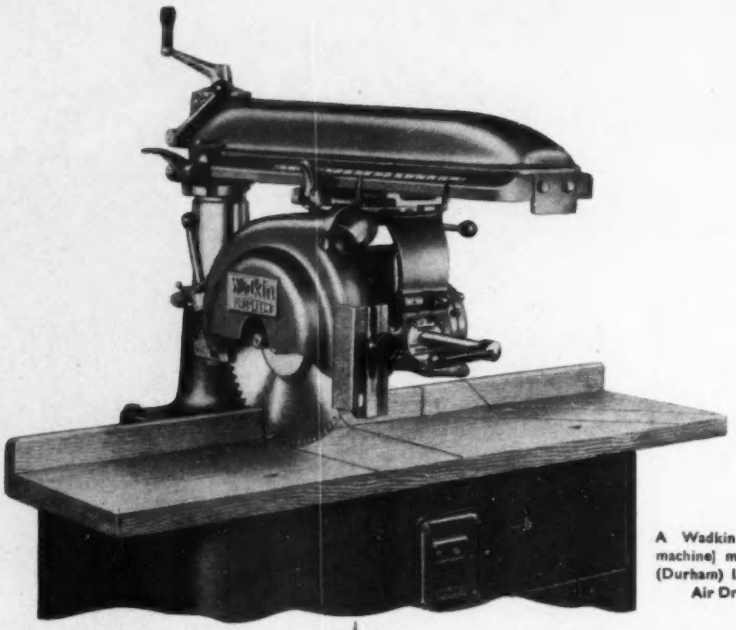
E704 Island Storage Tube will store about 500 bits of information and is designed for analogue and digital storage and for radar data handling applications, where it gives improved signal to noise ratio. The electrical input and output may be applied or taken out at the same or at different rates; the two processes may be simultaneous or sequential.

Full details of these and other EEV Storage Tubes will be sent on request.

AGENTS THROUGHOUT THE WORLD

ENGLISH ELECTRIC VALVE CO. LTD. *Chelmsford, England*
Telephone: Chelmsford 3491

AP149



A Wadkin Bursgreen woodworking machine] manufactured by Bursgreen (Durham) Ltd., and coated with Luxol Air Drying Hammered Finish.

Get sales off to a good start . . .

No range of Industrial Finishes can surpass Luxol; they offer the finest finish for every industrial need. Incorporating all the latest paint developments, Luxol Industrial Finishes provide the eye appeal which influences sales. If your requirements cannot be met from our standard range we will, on request, formulate a special finish for your particular purpose. For *any* information please write to the address below

with LUXOL Industrial Finishes

Selected finishes in the Luxol range:

LUXOL Standard Stoving Finish
LUXOL Quick Drying Finish
LUXOL Wrinkle Finish
LUXOL Cellulose Finish
LUXOL Hammered Finish
LUXOL Stoving Polychromatic Finish
LUXOL Polyurethanes
EPILUX 2 Stoving Finish

BY APPOINTMENT TO
HER MAJESTY QUEEN ELIZABETH II
MANUFACTURERS OF PAINT
BRITISH PAINTS LIMITED

BRITISH PAINTS LIMITED
Industrial Finishes Division
Portland Road, Newcastle upon Tyne, 2.
Northumberland House. 303-306 High Holborn, London, W.C.1.
31 Wapping, Liverpool.

Belfast, Birmingham, Bristol, Cardiff, Glasgow, Leeds, Manchester, Norwich, Plymouth, Sheffield, Southampton, Swansea and all principal towns.

BPL/IP30

EE 30 063 *for further details*

378 SMALL POWER TRANSFORMERS *

are included
amongst the 700
standard transformers and
chokes listed, priced and
fully described in the
NEW
Gardners loose leaf catalogue

* *for full-wave, bridge and contact cooled rectifiers; also auto, isolating and low voltage applications.*

Every copy of this catalogue, which has been prepared specially for industrial and research establishments, is numbered and registered in the name of the holder. It is regularly brought up to date by the supply of amendment sheets covering every addition to Gardners' standard ranges. Please apply on the Company's or the Establishment's official letterheading. For other users a catalogue covering the full Solent and Miniford series is available on request.

Please write for catalogue to

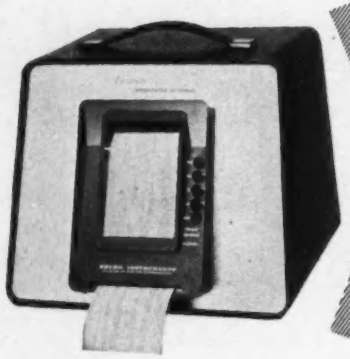
GARDNERS RADIO LTD., SOMERFORD, CHRISTCHURCH · *tel. 1734*

EE 30 064 *for further details*

UNDER ONE ROOF

INSTRUMENTS FROM A SELECTION OF
THE WORLD'S BEST MANUFACTURERS
IN BOTH GREAT BRITAIN AND OVERSEAS

***Brush* INSTRUMENTS**
Division of Clevite Corporation
CLEVELAND, OHIO, U.S.A.



Among the world's most advanced instrumentation for testing, monitoring or recording, Brush products are available NOW at Livingston Laboratories. They include direct-writing rectilinear recording systems, precision amplifiers for field or laboratory use, servo analyzers—and monitoring instruments for space vehicles!

In the field of instrumentation, Livingston Laboratories offer a unique service in the form of expert advice in the choosing of test equipment to meet your needs.
The relevant factors are not who makes it or where it is made, but will it do the job? At Retcar Street you can discuss the technical problems of instrumentation and the new techniques developed both in this country and abroad. If it is impossible to call—write or telephone about your particular problem or requirement and our representatives will supply you with full information.

Some of the manufacturers outside Great Britain whom we represent and for whose products we offer full service facilities:

BIRD ELECTRONIC CORP. • BOONTON RADIO CORP. • BRUSH INSTRUMENTS • DYMEC INC. • E.H. RESEARCH LABORATORIES INC. • ELECTRO SCIENTIFIC INDUSTRIES INC. • EMPIRE DEVICES PROD. CORP. • JOHN FLUKE MANUFACTURING CO. • GERTSCH PROD. INC. • HEWLETT-PACKARD CO. • KAY ELECTRIC CO. • KEITHLEY INSTRUMENTS INC. • ARTHUR KLEMT • MAGNETIC A.B. • F. L. MOSELEY CO. • NON:LINEAR SYSTEMS INC. • RADIO FREQUENCY LABORATORIES INC. • RADIOMETER • S.I.D.E.R. • TEKTRONIX INC. • TELECHROME MANUFACTURING CORP. • VARIAN ASSOCIATES (Microwave Tube Division).

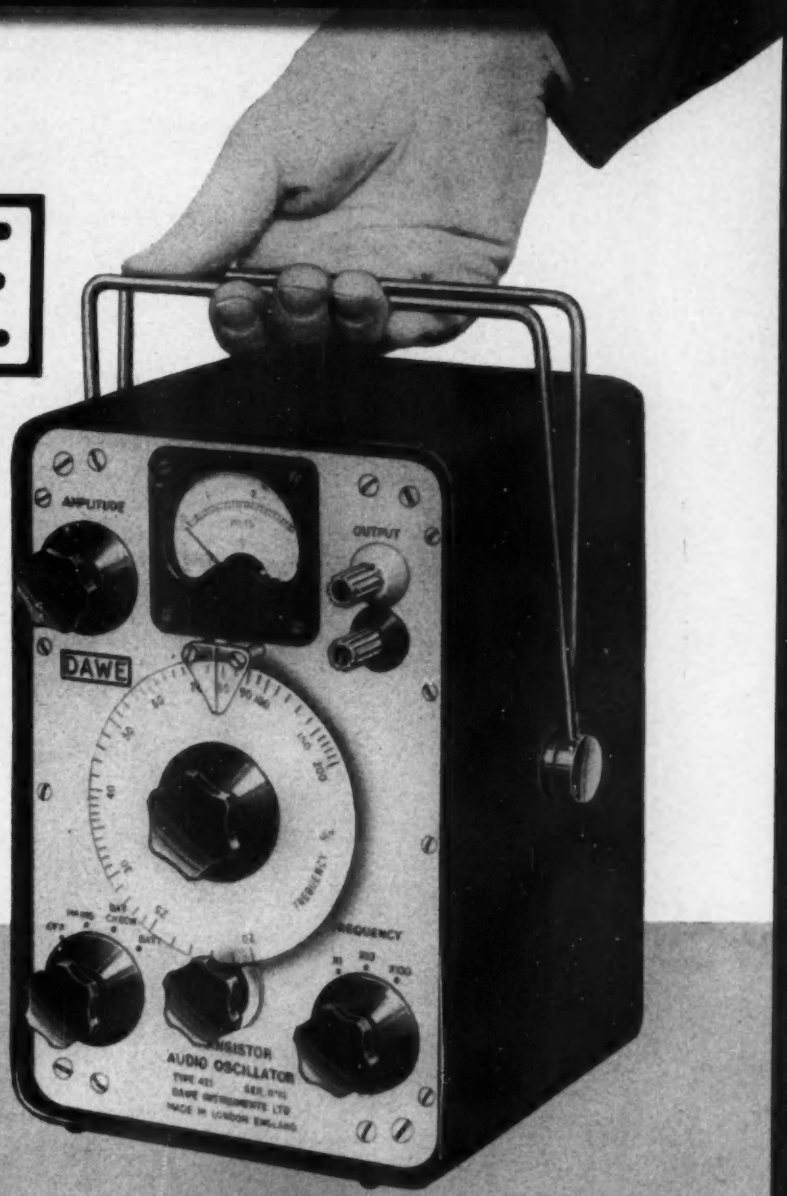
LIVINGSTON LABORATORIES LIMITED
RETCAR STREET · LONDON · N.19 Telephone: ARChway 6251

DAWE

TRANSISTOR AUDIO OSCILLATOR

TYPE 421

. . . covers the range 20c/s to 20kc/s with a high degree of amplitude and frequency stability



APPLICATION

This fully-transistorised instrument affords a continuously variable frequency coverage over the range 20 c/s to 20 kc/s. An exceptional frequency stability, virtually unaffected by temperatures and supply voltage variations, has been achieved. The low distortion, together with the internal battery and mains power units, make it ideal for use in the field or the laboratory.

- ★ **All-transistor operation**
- ★ **Performance comparable with thermionic valve instruments.**
- ★ **Low distortion.**
- ★ **High stability.**
- ★ **No warm-up period.**
- ★ **Freedom from microphony.**
- ★ **Self-contained batteries and mains power unit.**
- ★ **Very low power consumption.**

Frequency Range:
20 c/s to 20 kc/s in three ranges.

Accuracy:
±3%.

Output:
Variable up to 2.5V r.m.s. into 600Ω.

Output Level:
Constant within ±0.5dB.

Distortion:
Less than 1%.

Output Meter:
Calibrated 0 to 3V r.m.s.

Power Supply:
100-125V and 200-250V, 50-60 c/s, 2W approx. or self-contained batteries (eight Ever Ready Type U.11 or equivalent).

Mounting:
Extremely compact and portable black moulded cabinet fitted with a universal handle which can be used as an adjustable stand.

Dimensions:
6 in. wide x 5⅞ in. deep x 8⅞ in. high. (10½ in. over handle.)

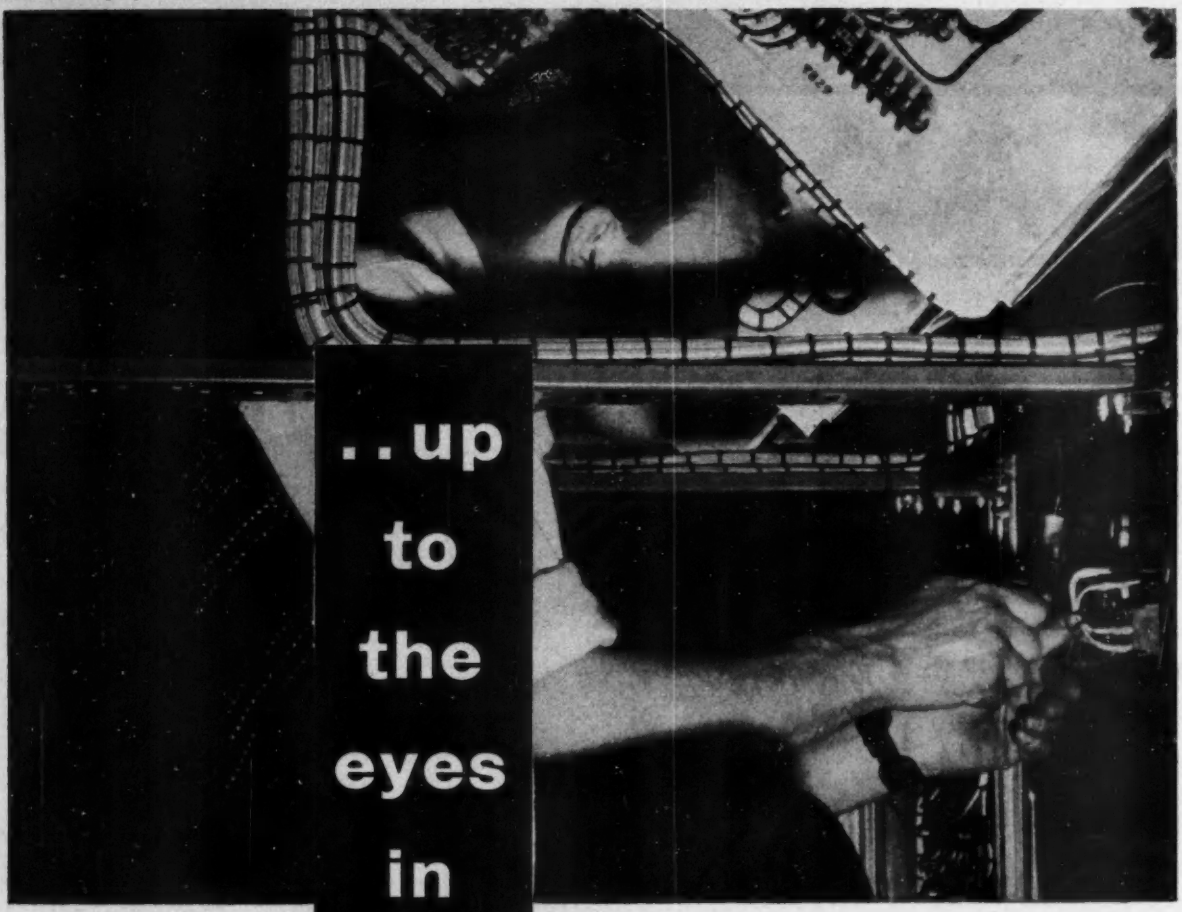
Weight:
5¾ lb. approx. with batteries.

Other fully-transistorised laboratory instruments include—A.C. Milliclamp Type 618, Phase Meter Type 630, Frequency Meter Type 715, Vibration Meter Type 1431.

Technical data forwarded on request: DAWE INSTRUMENTS LTD., HARLEQUIN AVENUE, GREAT WEST RD., BRENTFORD, MIDDX. : ISLeworth 7331/5

A MEMBER OF THE Simms GROUP OF COMPANIES

EE 30 066 *for further details*



..up to the eyes in it!

PLEASE HELP SPASTICS

Data amplifiers
Automatic typewriter system
Pressure & Load transducers
Torque Measurement
Electronic Design Service
Counter Timers

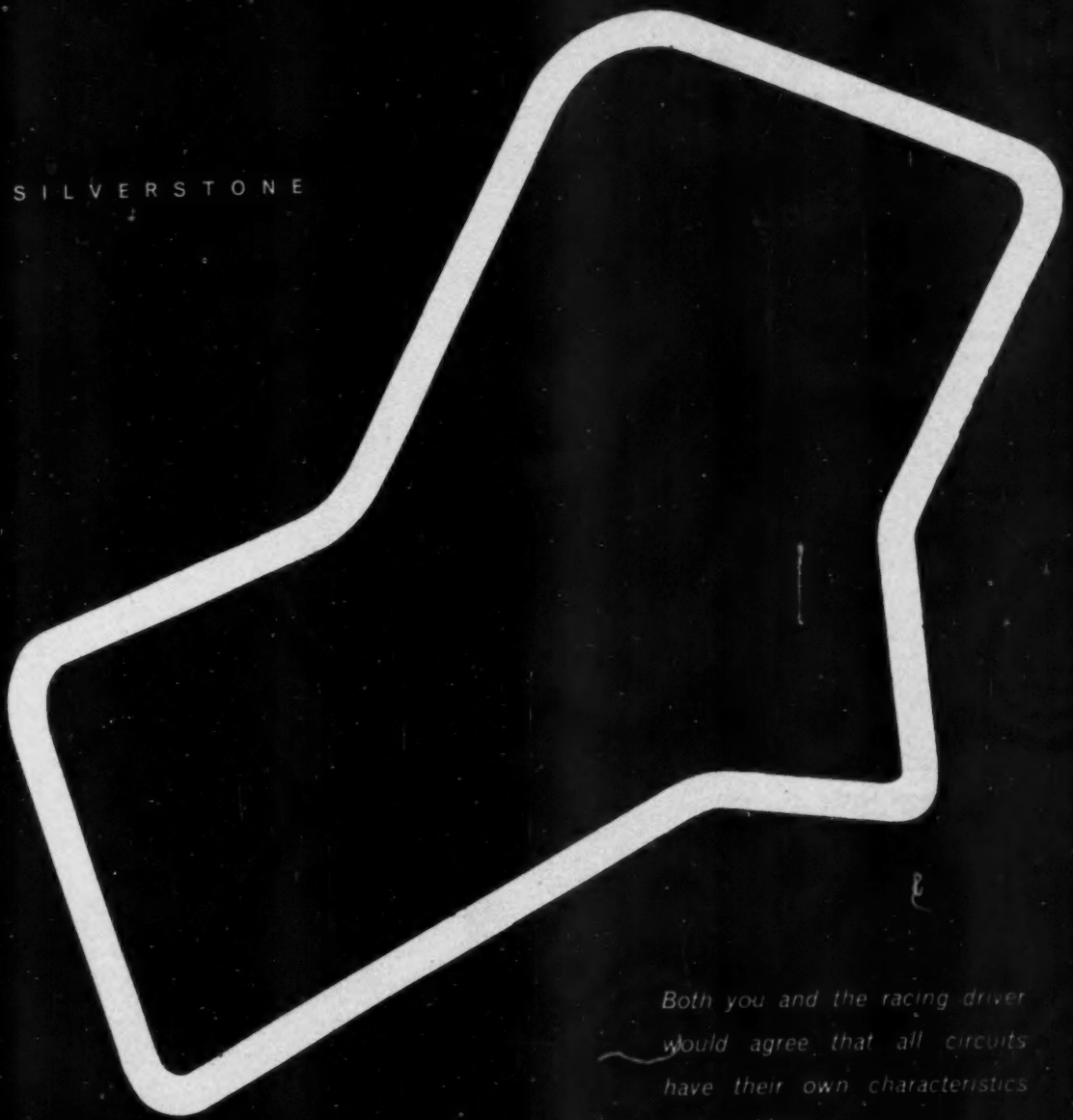
It takes a brilliant mind and an orderly one to design and develop new installations and electronic techniques appropriate to the problems of the 60's. The skilful manufacture to these designs by the craftsmen, using every type of aid, is equally important. Based on the experience of the Black Knight Research Vehicle Programme and a wide range of commercial contracts, the standard of neatness and finish, essential to long trouble-free life is a particular feature of Saunders-Roe electronic apparatus. If you have an engineering problem, we may be able to offer you a solution, based upon the latest electronics engineering techniques.

SAUNDERS — ROE

A member of the Westland group of companies

ELECTRONICS DIVISION
OSBORNE WORKS EAST COWES ISLE OF WIGHT
Telephone :- Cowes 2211

SILVERSTONE

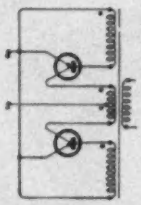


Both you and the racing driver would agree that all circuits have their own characteristics and problems . . . . . .
but for *you*, when selecting a valve for all round optimum performance . . . . . .
better make it BRIMAR

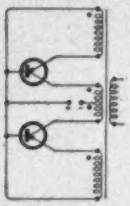
BRIMAR LIMITED · FOOTSCRAY · SIDCUP · KENT · FOOTSCRAY 3333

BVA

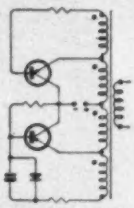
Avel Toroids . . .
for semi conductor circuits



COMMON BASE



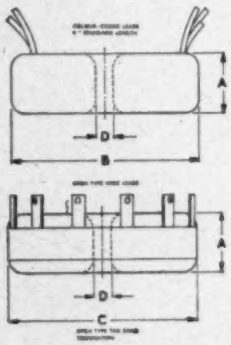
COMMON EMITTER



COMMON COLLECTOR

Bridge circuits, voltage doubler circuits, tripler and full-wave circuits can be used in the H/T. secondary.

TYPE		POWER
T/3B6/300/2T	...	2–5
T/5B6/300/2T	...	5–15
T/5AC6/300/2T	...	15–45
T/3B12/300/2T	...	2–5
T/5B12/300/2T	...	5–15
T/5AC12/300/2T	...	15–45
T/25C12/300/2T	...	45–75
T/3B24/300/2T	...	2–5
T/5B24/300/2T	...	5–15
T/5AC24/300/2T	...	15–45
T/25C24/300/2T	...	45–75
T/6AD24/300/2T	...	75–120
T/26D24/300/2T	...	120–150

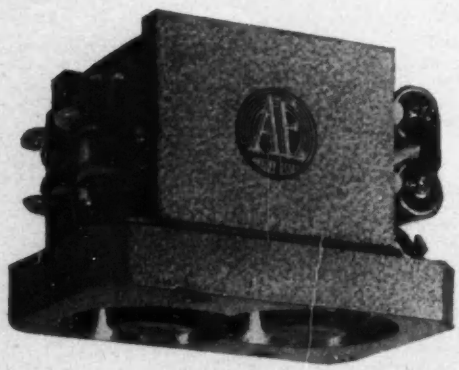


The use of AVEL TOROIDS gives higher efficiency in DC-DC Converters. Wide bandwidth and HCR alloy core ensures fast switching (approx. 3 micro-secs.) with negligible overshoot yielding efficiencies of 75-92% overall.

Watts Power Rating	A	B	C	D
2-5	¾	1⅛	1⅜	2 BA Min. Clear
5-15	¾	2	2¼	2 BA ,,
15-45	1¼	2	2¼	0 BA ,,
45-75	1¾	2	2¼	0 BA ,,
75-120	1¾	2⅛	2⅜	0 BA ,,
120-150	1⅞	2⅛	2⅜	0 BA ,,

DC - DC converters

- ★ Smaller 2¼"×2⅛"×3⅛"
- ★ More efficient 84% at 30W
- ★ Less noise
- ★ Less ripple
- ★ Better made



Built in aluminium castings, with fibre-glass insulation, silicon rectifiers and tropical rating components throughout, these converters achieve peak performance at modest cost by good design—and are available on short delivery in skeleton form (left) or in screening cases with complete protection for use as replacements for generators and vibrator packs. Standard types give 300 volts DC output with taps for 250 and 200 volts.

Type	3B6	5B6	5AC6	3B12	5B12	5AC12	25C12	3B24	5B24	5AC24	25C24
Input, Volts ...	6	6	6	12	12	12	12	24	24	24	24
Max. Watts ...	5	15	45	5	15	45	75	5	15	45	75
List Price ...	£10 8s.	£10 14s.	£11 16s.	£10 8s.	£10 14s.	£11 16s.	£12 4s.	£11	£11 8s.	£12 8s.	£12 14s.

Manufacturers Terms on Application

TOROID DIVISION

Aveley Electric Limited

SOUTH OCKENDON, ESSEX
Telephone: South Ockendon 3444
Telex: 24120 Avel Ockendon

P5387

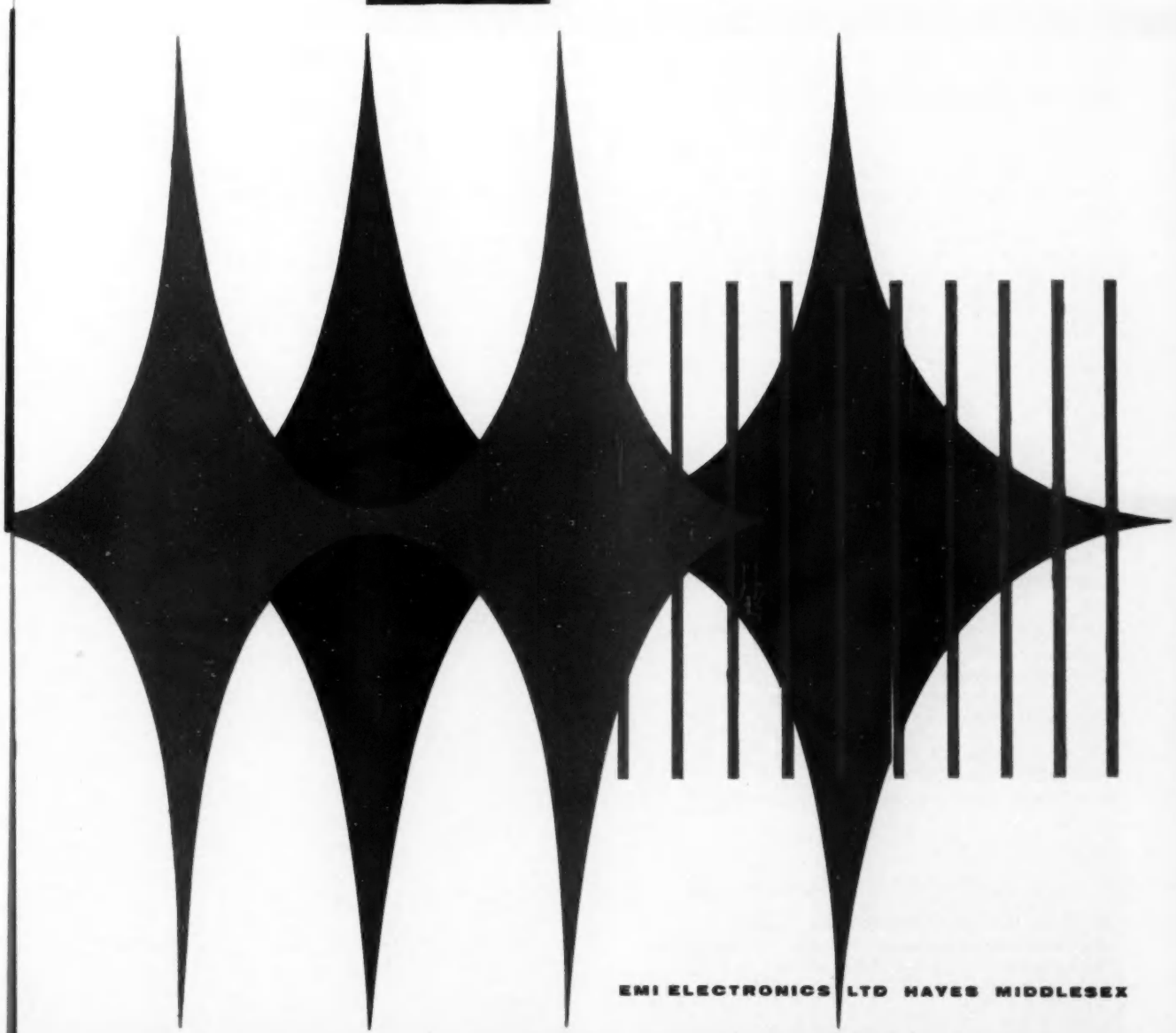
TEAR ALONG THIS PERFORATION

Overleaf the new Selection Charts for Klystrons and Photomutiplier Tubes.

Your new detachable short catalogue of

EMI

Precision Instruments



EMI ELECTRONICS LTD HAYES MIDDLESEX

NUCLEAR HEALTH INSTRUMENTS

PORTABLE CONTAMINATION MONITOR TYPE 1

TOP LEFT Simultaneously monitors Alpha and Beta/gamma contamination.
Transistors used for long life and dependability.
Audible and visual indication of contamination from 0-5000 counts/sec.

HAND AND CLOTHING MONITOR TYPE 1

LEFT Simultaneous monitoring for Alpha and Beta/gamma
Audible and visible warnings of count.
Background radiation compensation.
Independent probes for Alpha and Beta/gamma contamination.

PROBES

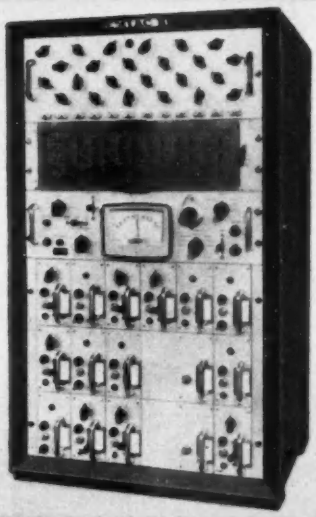
A range of probes is available:

1. AP2 50 cm^2 alpha probe, using a scintillation counter.
2. AP3 100 cm^2 alpha probe, using a scintillation counter.
3. BP2 Beta-Gamma probe, using a B12H geiger counter.
4. BP3 Beta-Gamma probe, using a B12H geiger counter.
5. DP2 50 cm^2 dual phosphor probe for Alpha and Beta/gamma monitoring.
6. GP2 Gamma probe, using Na I crystal and scintillation counter.
7. BP4 low energy Beta probe using a scintillation counter.

ANALOGUE COMPUTERS

EMIAC II

RIGHT **A general purpose analogue computer of flexible design. One of the most advanced instruments of its kind, it enables the smallest user to order a "one-off" Computer at a mass production price, while the largest organisation can obtain a general purpose computer, or a special simulator of any desired size and characteristics.**



ELECTRONIC PHOTOGRAPHIC EQUIPMENT

CONTACT PRINTER TYPE CP18S. ENLARGER TYPE EP10

Electronic control of dodging and exposure of photographic negatives.
More detail from both shadows and highlights.
Consistent repetitive prints.

CONTACT PRINTER, TYPE CP 18S

RIGHT **Prints from cut negatives from 2¼ in. square to 14" x 18".**

Please write for full information or a demonstration

E.M.I. ELECTRONICS LTD
INSTRUMENT DIVISION · HAYES · MIDDLESEX
TEL: SOUTHALL 2468, EXT. 2223

EMI

Klystron and waveguide data

SELECTION CHART

BAND	L	S	C	X	Ku	K	Ka	Q	M	O(E)
Gc/s	1·12 – 1·7	2·6 – 3·95	5·85 – 8·2	12·4 – 18	26·5 – 40	60 – 90

BRITISH (WG) AND	WG6:RG69/U	WG8:RG104/U	WG10:RG48/U	WG12:RG49/U	WG14:RG50/U	WG16:RG52/U	WG18:RG91/U	WG20:RG53/U	WG22:RG96/U	WG24	WG26:RG99/U
US (RG) WAVEGUIDE		WG9:RG112/U	WG11	WG13	WG15:RG51/U				RG97/U	RG98/U	
Gc/s	2·2	3·3	4·9	7·05	10·0	33	50	75

EMI KLYSTRON

Low voltage, low power reflex oscillators
High voltage, low power reflex oscillators
High voltage, medium power reflex oscillators
4-cavity pulse amplifier Klystron
Plug-in tubes for external resonators
Planned and under development
Rugged types
Using replaceable tubes

ING

many
ompu-
and in
noise
les are
unnel
s; and
core
being

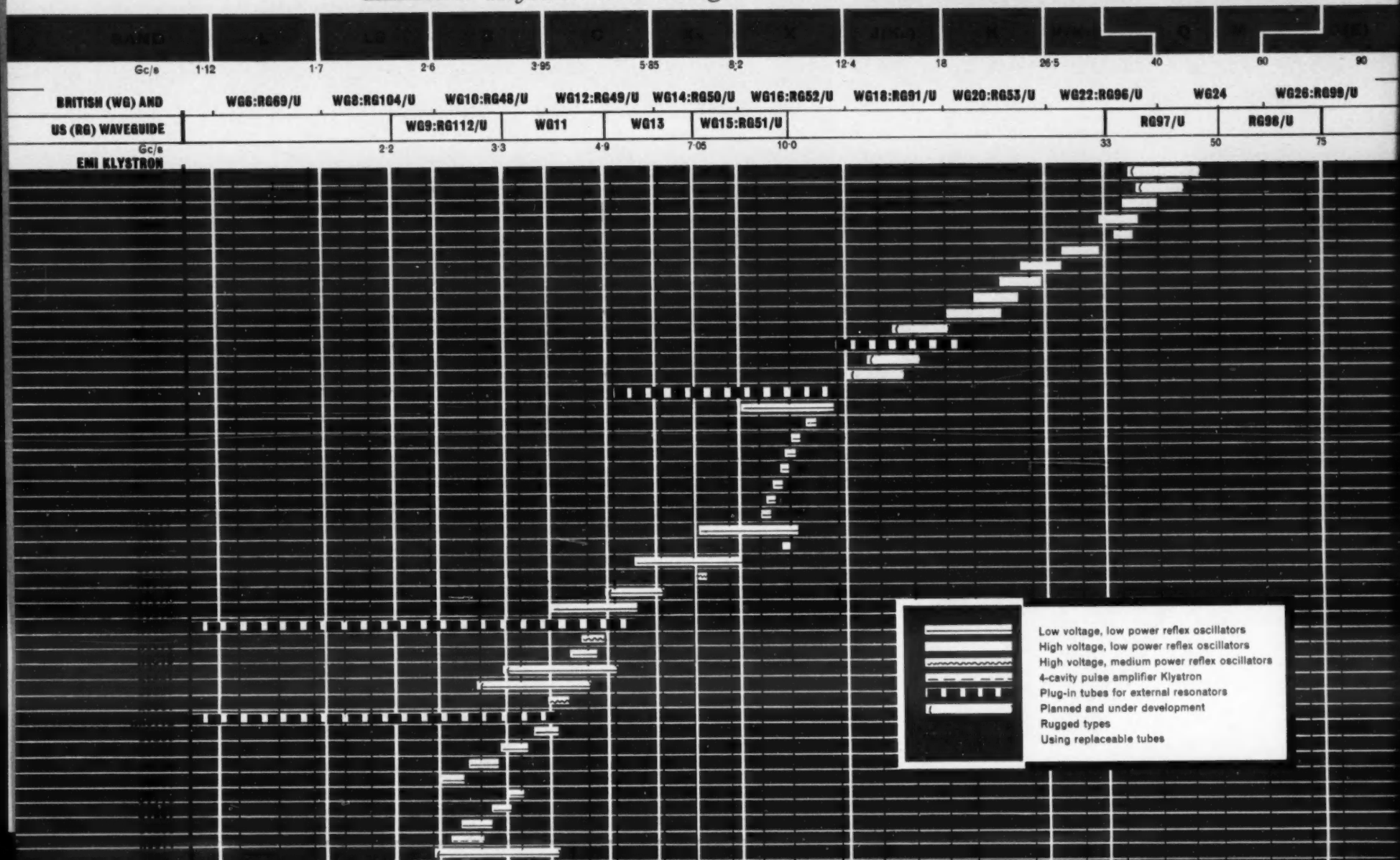
details

S?

EMI

Klystron and waveguide data

SELECTION CHART



EMI

Photomultiplier tube selection chart

PHOTOCATHODE DATA

The range of spectral sensitivity is given with quantum efficiency (Electrons per photon) at points indicated. Tubes having given end-window cathode type are listed.

WAVELENGTH · Microns. 0 · 0·2 · 0·4 · 0·6 · 0·8 · 1·0 · 1·2

AgMgO surface in vacuo. 9603 Particle multiplier.

Developmental tubes with LiF windows.

Developmental tubes with Sapphire windows.

Au on fused Silica	6255G
Mg on fused Silica	6255Mg
SbCs on fused Silica	"S" Cathode on Silica. 6255S, 6256S, 9526S, 9552S
SbCsO on fused Silica	S13. 6255B, 6256B, 9526B, 9530Q, 9531Q, 9552B,
BiAgOCs on fused Silica	S10 on Silica. 9529B
SbNaKCs on fused Silica	Trialkali on Silica. 9558Q
AgOCs on fused Silica	Developmental S1 on Silica
BiAgOCs on U.V. glass	S10. Extended response. 9592B
SbCsO on U.V. glass	S11. Extended response. 9621B
SbNaK on glass 25 μA/L	Bialkali. Cathode. 9607B. For operation up to 150°C.
SbCs on glass 40 μA/L	"S" Cathode. 6097S, 9502S, 9514S, 9524S, 9536S
SbCsO on glass 70 μA/L	S11. 6094B, 6097B, 9502B, 9514B, 9524B, 9530B, 9531B, 9536B, 9545B, 9578B, 9579B, 9583B, 9584B, 9593B, 9618B, (9623B
BiAgOCs on glass 30 μA/L	S10. 6095B, 9554B
SbNaKCs on glass 150 μA/L	S20. 9558B, 9578TA
AgOCs on glass 15 μA/L	S1. 9553B

DYNODE CHARACTERISTICS

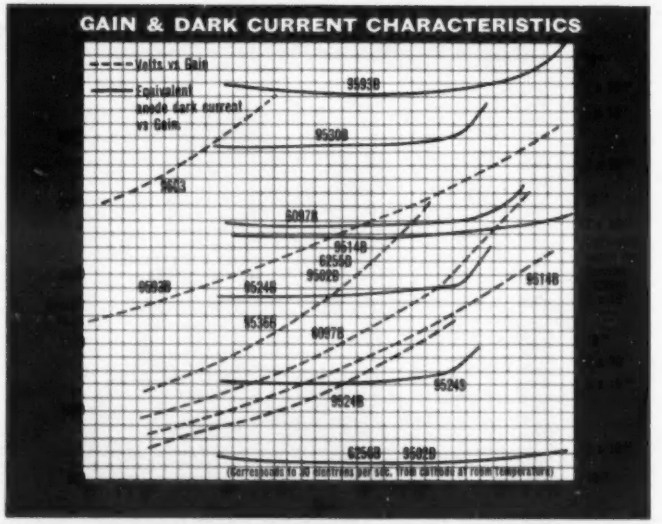
Tubes are made with dynode structures appropriate to their application.

Box & Grid (Coated with SbCs). Give very high stage gain at low voltage and are used in small diameter tubes (e.g. 9524B) particularly for portable apparatus. Time characteristics are relatively poor, and peak anode currents are limited to about 50mA.*

Venetian Blind dynodes (SbCs Coated). Give good average gain and very low dark currents. The large diameter allows of good collection efficiency from the cathode. Rise times of 2" tubes are about 7 nanoseconds and peak currents up to 300 mA may be drawn.

Focused structures (AgMgOCs) give very good time characteristics, with rise times around 2½ nanosecs, but gain is relatively lower than the other types and dark current worse. AgMgO dynodes (whether F or VB) made without Cs in the tube (e.g. 6255G, 9607) give low gains and require high voltage for operation. Dark Current in μA divided by overall sensitivity in Amps per Lumen gives equivalent Dark Current in Lumens and should be independent of gain. (*Note. Average anode currents are limited to 1mA max.)

GAIN & DARK CURRENT CHARACTERISTICS



Note: The dark current of a PM tube may be relatively high when the tube is first operated, but will quickly decrease during operation in the dark, and may go on decreasing for several days before reaching a limiting value.

For further details, please write or telephone: **E.M.I. ELECTRONICS LTD**

ENVELOPE DIAMETER

¼" 13mm	1" 25mm	2" 50mm	3"	5" 130mm	7"	10"	12" 300mm
	11BG 9524 9526 9529 9592 9600* 9621 (B14B)	10VB 9536 9552 9553 9554 (B14A)	10VB 9578 (B14A)	10VB 9579 (B14A)	11VB 9623 (B15B)		11VB 9545 (B15B)
		11VB 9584 (B14A)	11VB 9531 (B15B)	11VB 9583 (B14A) 9530 9618 (B15B)			
Developmental		6094** 6095 6097 (B15B)					
		9558 9607† (B19A)					
		13VB 6255 6256** 9502** 9514 (B15B)					
		14F 9593‡ (B19A)					

NOTES † AgMgO coated dynodes.

‡ AgMgOCs coated dynodes.

All other tubes have SbCs coated dynodes.

** 10mm cathode.

* Side Wall Sensitive 20cm² total cathode area.

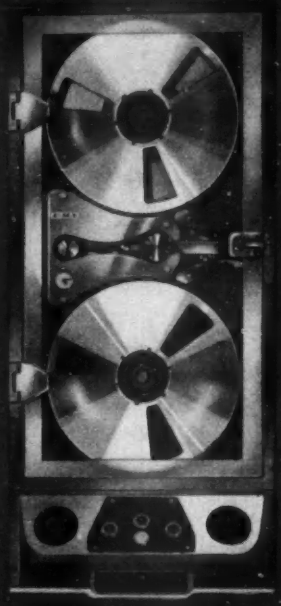
B14A is a Diheptal base, all other bases are of glass.
PTFE Sockets are available for the glass base tubes.
The operation of PM tubes may be affected by magnetic fields and μ-metal shields are available.
PM tubes should not be operated at excessive light levels with voltage applied.
Dark current is dependent on operating temperature. The data given refers to 20°C. A reduction in temperature to —10°C will give a decrease of ca. 10:1.

VALVE DIVISION · HAYES · MIDDX. Tel: SOUthall 2468 Ext 2165

TEAR ALONG THIS PERFORATION

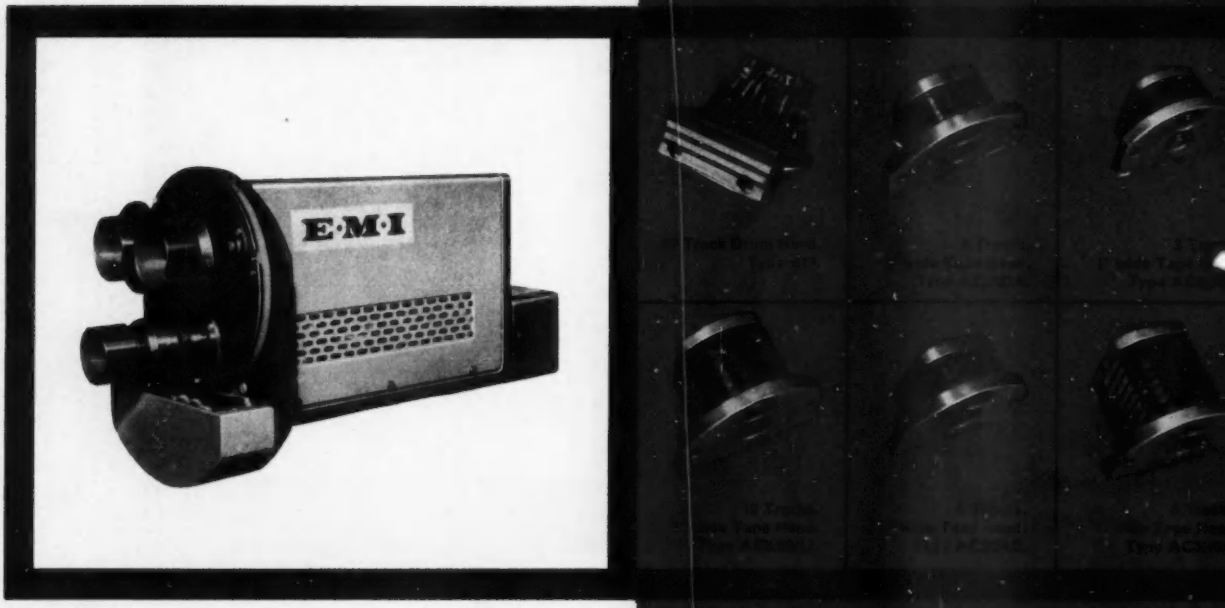
INSTRUMENTATION TAPE DECKS

RIGHT Six tape speeds available.
Four multitrack magnetic heads (up to 24 tracks per 1" tape) can be employed.
Tape speed ratios up to 128 : 1.
Up to 14" diameter tape spools can be used.
Versions available for 1", ¾", ½" and ¼" wide tape.
Tape speeds available cover the range ¼ in/sec-120 in/sec.
Fast bi-directional spooling.



EMIDATA MULTITRACK HEADS

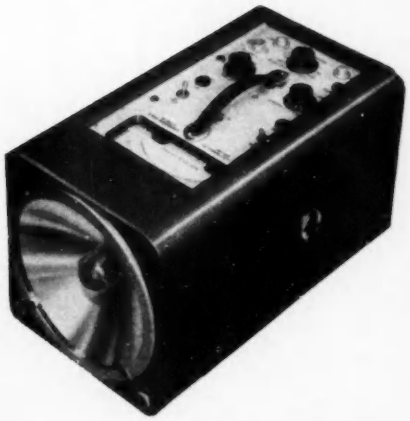
RIGHT CENTRE Interleaving pairs provide up to 24 tracks on 1" wide tape. Precise assembly ensures repeatability and long working life.
Accurate gap-alignment can be provided. Superior cross-talk rejection and good low-frequency response.
Ranges available for in-contact and out of contact use.



CLOSED CIRCUIT TELEVISION

ABOVE BLACK AND WHITE TELEVISION CAMERA MARK VI Uses the EMI 1" vidicon tube.
Bandwidth: 8 mc/s.
Linearity: Better than 2% for line and field.
Sensitivity: Full Camera Control Unit output with an illumination of 1 ft. candle (50% reflectivity with lens at F/2).
Full range of accessories, for remote operation, available.

RIGHT COLOUR TELEVISION Suitable for industrial, studio or medical applications. Three vidicon camera with a special optical system giving high sensitivity under difficult lighting conditions.
Available for 405, 525 and 625 standards.
Fitted with four lens turret.
For use with colour projectors or receivers.



STROBOSCOPES

STROBOSCOPE TYPE 6

LEFT Flash rate: 5-1000 flashes per second in four continuous ranges.
Accuracy: 1% of F.S.D.
Flash duration: 31μ sec to 8.5μ sec varying with rate.

STROBOSCOPE TYPE 3D

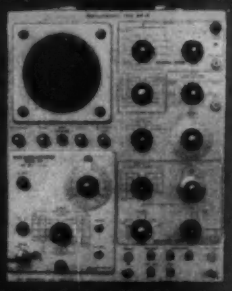
Flash rate: 5-100 flashes per second in two continuous ranges.
Accuracy: 1% of F.S.D.
Flash duration: 16μ sec to 9μ sec depending on rate.

STROBOSCOPE TYPE 5C

A portable hand-operated stroboscope. Flash rate: 10-100 flashes per second.
Accuracy: 10% F.S.D.

OSCILLOSCOPES

OSCILLOSCOPE TYPE WM16



Bandwidth: DC-40 Mc/s (± 3dB).
Maximum sensitivity: 50 mV/cm.
Sweep speeds: 20 mμs/cm-0·5 s/cm.
Sweep delay: 1μ sec-150 m sec.
Direct time and voltage measurement: ± 3%.
Built-in signal delay: 0.2μS.
Plus range of plug-in units.
Full range of attenuator probes from 5 : 1 to 100 : 1.

OSCILLOSCOPE TYPE WM8

Bandwidth: DC-15 Mc/s (± 3dB).
Maximum sensitivity: 50 mV/cm.
Sweep speeds: 50 mμs/cm-15 ms/cm.
Time measurement by dial: ± 2%.
Voltage measurement: ± 3% F.S.D by built-in voltmeter.

DISTRIBUTED AMPLIFIER TYPE 2C

Frequency range: 50 c/s to 100 Mc/s.
Maximum output: 100v pk-pk.
Gain: X 12.
Risetime: 5 mμ sec.

PULSE GENERATOR TYPE 1

Risetime: 1 mμ sec.
Pulse amplitude: + 125v to —125v.
Pulse repetition rate: 50 to 150 cps.
Pulse width: 4, 50 and 100 mμ sec.

STROBOSCOPES

STROBOSCOPE TYPE 6

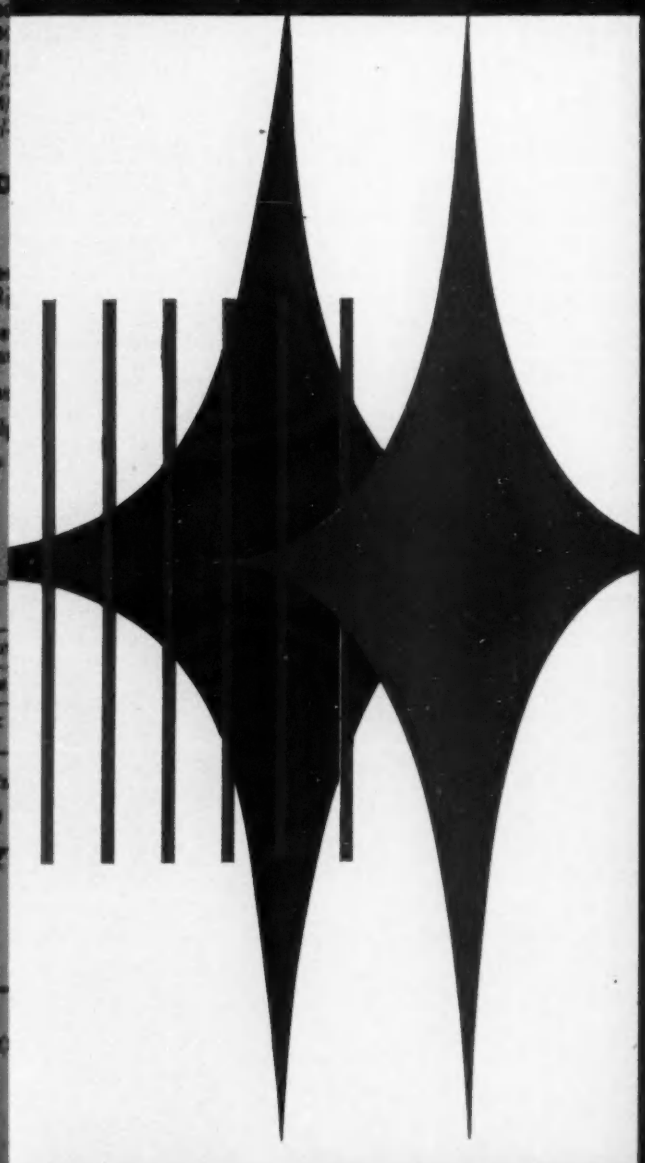
LEFT Flash rate: 5-1000 flashes per second in four continuous ranges.
Accuracy: 1% of F.S.D.
Flash duration: 31μ sec to 8.5μ sec varying with rate.

STROBOSCOPE TYPE 3D

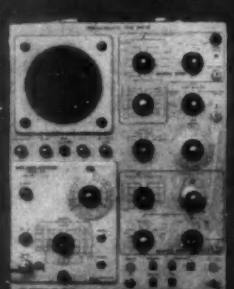
Flash rate: 5-100 flashes per second in two continuous ranges.
Accuracy: 1% of F.S.D.
Flash duration: 16μ sec to 9μ sec depending on rate.

STROBOSCOPE TYPE 5C

A portable hand-operated stroboscope. Flash rate: 10-100 flashes per second.
Accuracy: 10% F.S.D.



OSCILLOSCOPES



OSCILLOSCOPE TYPE WM16

Bandwidth: DC-40 Mc/s ($\pm$ 3dB).
Maximum sensitivity: 50 mV/cm.
Sweep speeds: 20 mμs/cm-0·5 s/cm.
Sweep delay: 1μ sec-150 m sec.
Direct time and voltage measurement: $\pm$ 3%.
Built-in signal delay: 0.2μS.
Plus range of plug-in units.
Full range of attenuator probes from 5 : 1 to 100 : 1.

OSCILLOSCOPE TYPE WM8

Bandwidth: DC-15 Mc/s ($\pm$ 3dB).
Maximum sensitivity: 50 mV/cm.
Sweep speeds: 50 mμs/cm-15 ms/cm.
Time measurement by dial: $\pm$ 2%.
Voltage measurement: $\pm$ 3% F.S.D by built-in voltmeter.

DISTRIBUTED AMPLIFIER TYPE 2C

Frequency range: 50 c/s to 100 Mc/s.
Maximum output: 100v pk-pk.
Gain: X 12.
Risetime: 5 mμ sec.

PULSE GENERATOR TYPE 1

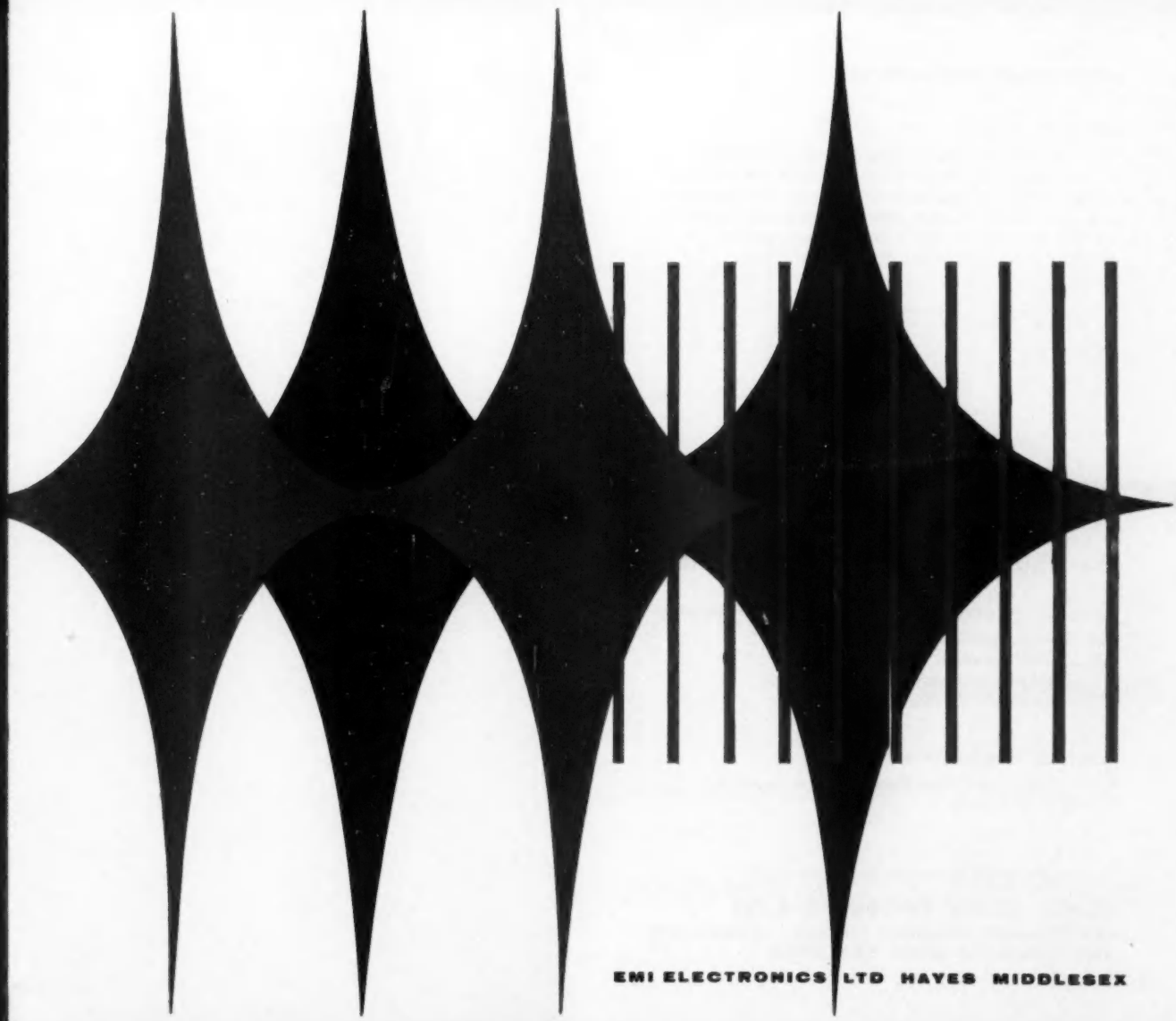
Risetime: 1 mμ sec.
Pulse amplitude: +125v to —125v.
Pulse repetition rate: 50 to 150 cps.
Pulse width: 4, 50 and 100 mμ sec.

Overleaf the new Selection Charts for Klystrons and Photomutiplier Tubes.

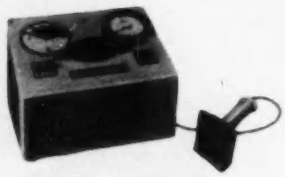
Your new detachable short catalogue of

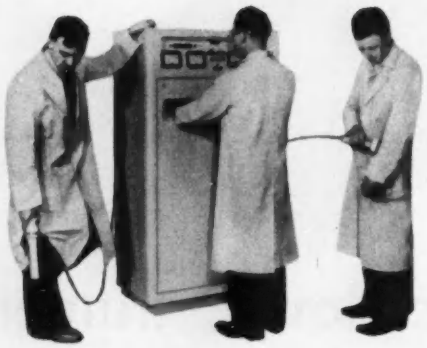
EMI

Precision Instruments



EMI ELECTRONICS LTD HAYES MIDDLESEX





NUCLEAR HEALTH INSTRUMENTS

PORTABLE CONTAMINATION MONITOR TYPE 1

TOP LEFT Simultaneously monitors Alpha and Beta/gamma contamination.
Transistors used for long life and dependability.
Audible and visual indication of contamination from 0-5000 counts/sec.

HAND AND CLOTHING MONITOR TYPE 1

LEFT Simultaneous monitoring for Alpha and Beta/gamma
Audible and visible warnings of count.
Background radiation compensation.
Independent probes for Alpha and Beta/gamma contamination.

PROBES

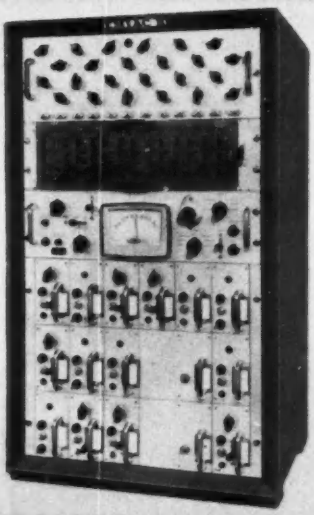
A range of probes is available:

1. AP2 50 cm^2 alpha probe, using a scintillation counter.
2. AP3 100 cm^2 alpha probe, using a scintillation counter.
3. BP2 Beta-Gamma probe, using a B12H geiger counter.
4. BP3 Beta-Gamma probe, using a B12H geiger counter.
5. DP2 50 cm^2 dual phosphor probe for Alpha and Beta/gamma monitoring.
6. GP2 Gamma probe, using Na I crystal and scintillation counter.
7. BP4 low energy Beta probe using a scintillation counter.

ANALOGUE COMPUTERS

EMIAC II

RIGHT A general purpose analogue computer of flexible design. One of the most advanced instruments of its kind, it enables the smallest user to order a "one-off" Computer at a mass production price, while the largest organisation can obtain a general purpose computer, or a special simulator of any desired size and characteristics.



ELECTRONIC PHOTOGRAPHIC EQUIPMENT

CONTACT PRINTER TYPE CP18S. ENLARGER TYPE EP10

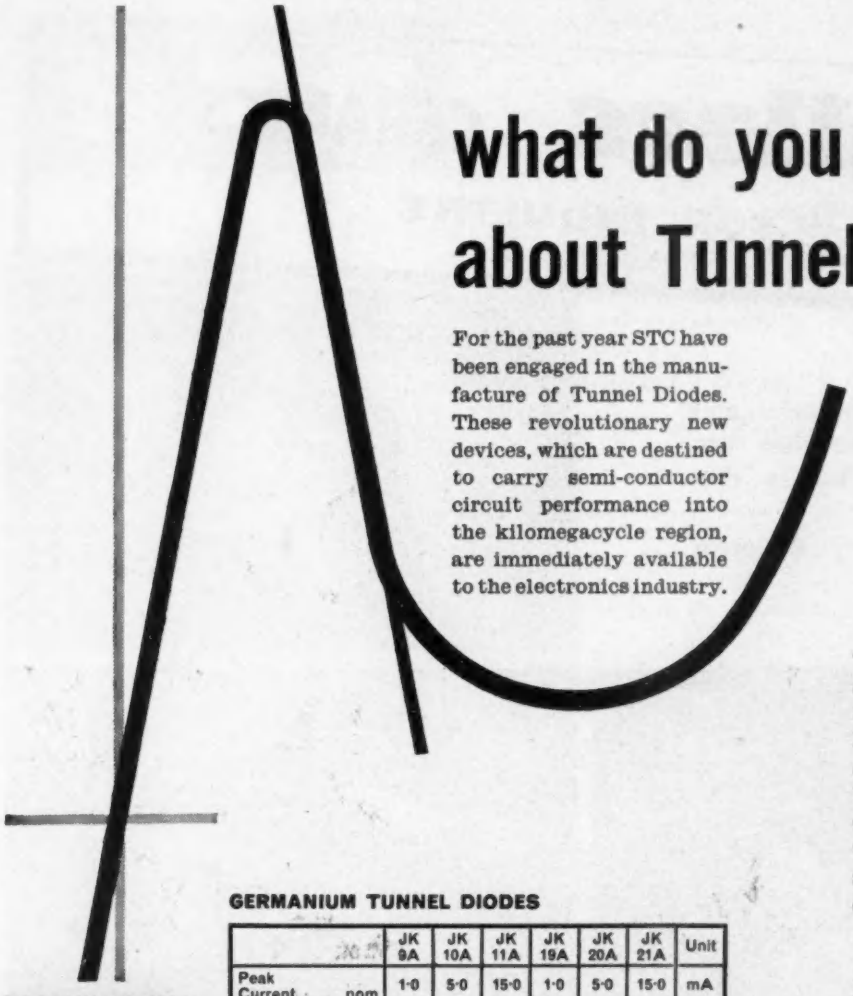
Electronic control of dodging and exposure of photographic negatives.
More detail from both shadows and highlights.
Consistent repetitive prints.

CONTACT PRINTER, TYPE CP 18S

RIGHT Prints from cut negatives from 2½ in. square to 14" x 18".

Please write for full information or a demonstration

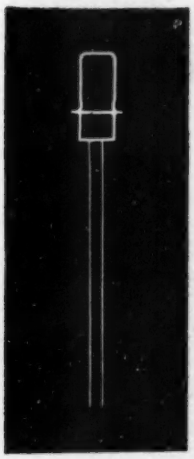
E.M.I. ELECTRONICS LTD
INSTRUMENT DIVISION · HAYES · MIDDLESEX
TEL: SOUTHALL 2468, EXT. 2223



what do you know about Tunnel Devices?

For the past year STC have been engaged in the manufacture of Tunnel Diodes. These revolutionary new devices, which are destined to carry semi-conductor circuit performance into the kilomegacycle region, are immediately available to the electronics industry.

Tunnel diodes are finding many applications in digital computers, counting circuits and in high-frequency low-noise amplifiers. Backward diodes are being used for gating in tunnel diode circuits; as limiters; and their possibilities in core switching circuits are being explored.



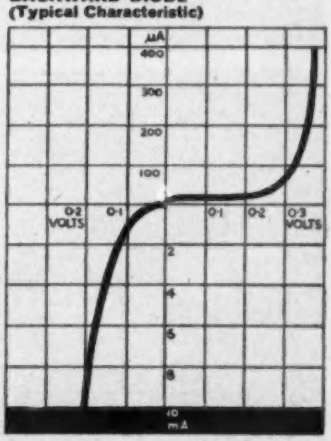
GERMANIUM TUNNEL DIODES

	JK 9A	JK 10A	JK 11A	JK 19A	JK 20A	JK 21A	Unit
Peak Current nom	1·0	5·0	15·0	1·0	5·0	15·0	mA
Current Ratio typ	4	4	4	6	6	6	
Junction Capacitance typ	25	50	125	10	40	80	pF
Resistive cut-off Frequency typ	540	810	810	1200	880	1100	Mc/s

BACKWARD DIODE

Typical Characteristics		Unit
Current in high resistance direction. (V_R=200mV)	10	μA
Current in low resistance direction. (V_F=200mV)	10	mA
Slope resistance. (V_F=400mV)	1·1	Ω
Shunt capacitance. (V_R=200mV)	90	pF

BACKWARD DIODE
(Typical Characteristic)



Full details of these devices may be obtained on request from

COMPONENTS GROUP

61/6MK

Standard Telephones and Cables Limited

Registered Office: Connaught House, Aldwych, London W.C.2

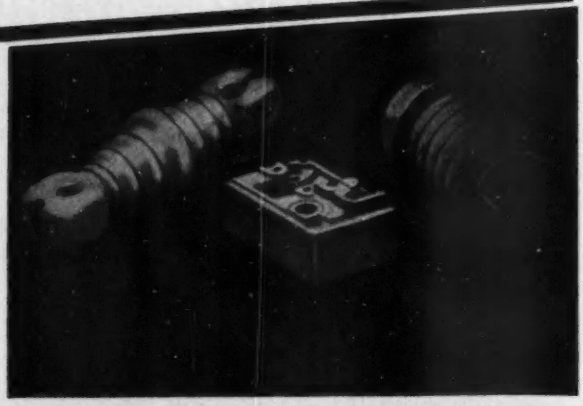
TRANSISTOR DIVISION: FOOTSCRAY · SIDCUP · KENT

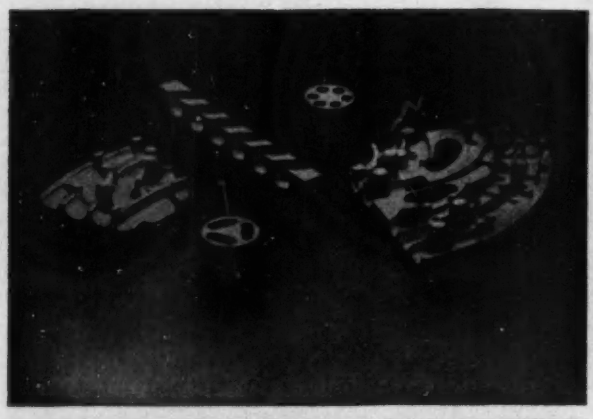
EE 30 070 *for further details*

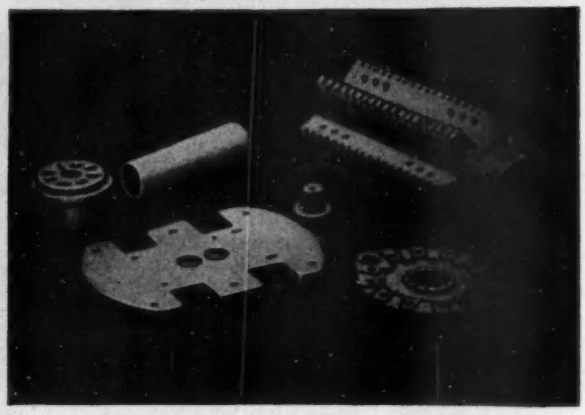
Bullers CERAMICS

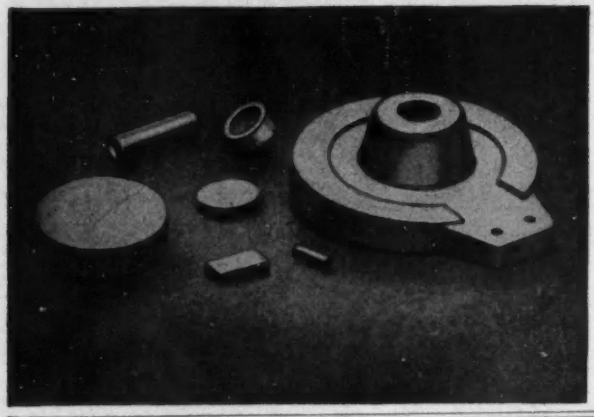
FOR INDUSTRY

High quality material and dimensional precision are attributes of Bullers die-pressed products.
Prompt delivery at competitive prices.









We specialise in the manufacture of

PORCELAIN
for general insulation

REFRACTORIES
for high-temperature insulation

FREQUELEX
for high-frequency insulation

PERMALEX & TEMPLEX
for capacitors

BULLERS LIMITED
MILTON · STOKE-ON-TRENT · STAFFS
Phone: Stoke-on-Trent 54321 (5 lines) · Telegrams & Cables: Bullers, Stoke-on-Trent
Ironworks: TIPTON, STAFFS Phone: Tipton 1691
London Office: 6 LAURENCE POUNTNEY HILL, E.C.4 Phone: MANsion House 9971

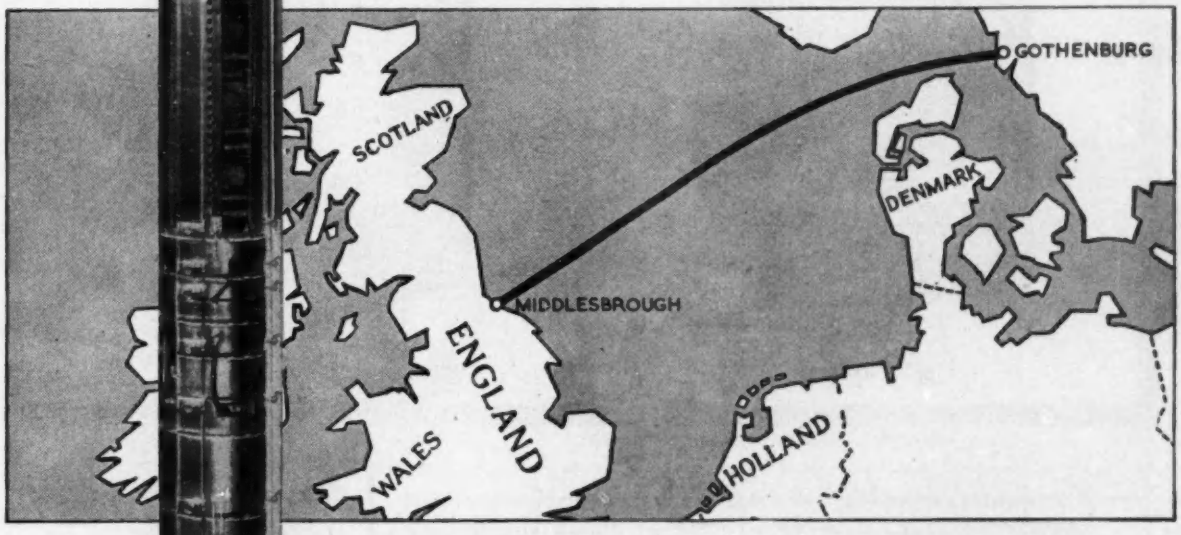
STC

Anglo-Swedish submarine cable telephone system

jointly owned by the B.P.O. and the Swedish Royal Board of Telecommunications was put into service in October, 1960 and is

the longest 2-way telephone system on a single submarine cable

Using 29 submerged repeaters and one submerged equaliser, it will handle 60 telephone circuits of 4 kc/s spacing over the 509 nautical mile (943 km) cable supplied by STC. STC have also supplied more than 40 racks of equipment for installation at the Middlesbrough and Gothenburg terminals.



The internal unit of an STC submerged repeater.

STC is one of the few commercial organisations in the world, technically equipped to plan, design and supply complete submarine cable communication systems.

Publication C/2050 lists major STC submarine telephone installations.

COMMUNICATIONS GROUP

61/2C

Standard Telephones and Cables Limited

Registered Office: Connaught House, Aldwych, London W.C.2

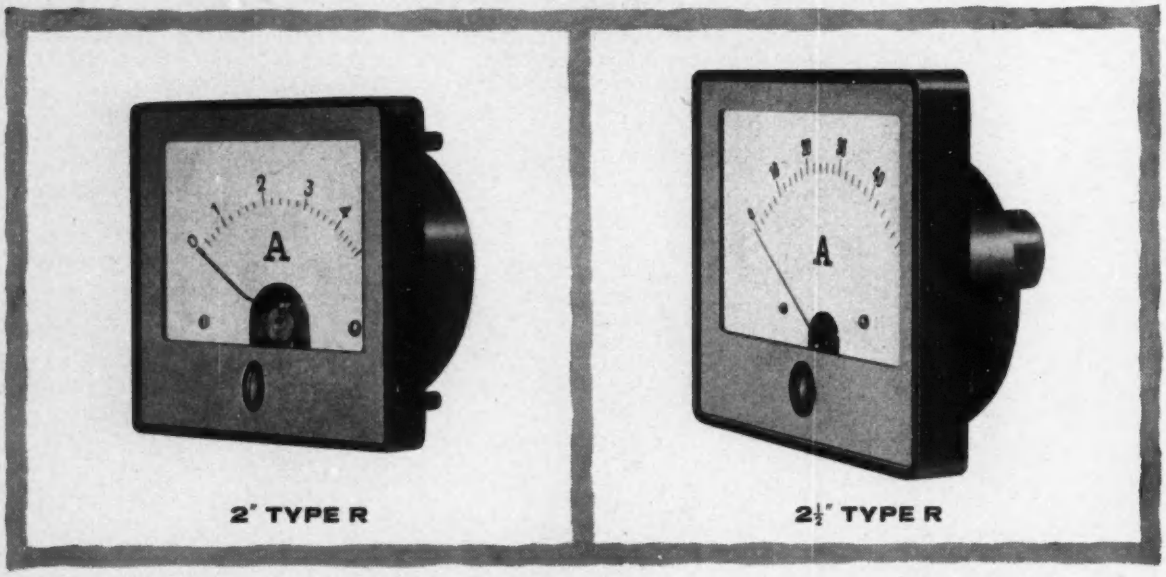
TRANSMISSION SYSTEMS DIVISION: NORTH WOOLWICH · LONDON · E.16

EE 30 072 *for further details*

SALFORD new Type R

PANEL MOUNTING INSTRUMENTS

2"-2½"-3½"-5"



2" TYPE R

2½" TYPE R

A unique feature of this new range is the front plate of anodised aluminium, supplied in any colour to match surrounding apparatus. The case, of clean rectangular styling is moulded in phenolic material, and fixing is easy and adaptable.
Instruments can be supplied for the measurement of all A.C. and D.C. currents and voltages.
The legibility of the scale is exceptional and all unnecessary markings have been eliminated. Scales are white enamelled on metal with black markings.

MOVING COIL TYPE
MOVING COIL WITH RECTIFIER
MOVING COIL WITH THERMO COUPLE
MOVING IRON TYPE

Send for leaflets

SALFORD ELECTRICAL INSTRUMENTS LTD.
PEEL WORKS, SILK STREET, SALFORD 3, LANCASHIRE. Tel: Blackfriars 0688
London Sales Office: Magnet House, Kingsway, W.C.2. Tel: Temple Bar 4668
A Subsidiary of THE GENERAL ELECTRIC CO. LTD. OF ENGLAND

tested to withstand overloads of 10 times nominal value!

ensure CONSISTENT magnetic characteristics

with STC

permalloys & permendur

PERMALLOY 'C'
for highest initial permeability, useful for wide-band frequency transformers, current transformers, chokes, relays and magnetic shielding.

PERMALLOY 'B'
has lower initial permeability than Permalloy 'C' but has a higher value of flux density. It is suitable for use where high permeability to an alternating field superimposed upon a steady polarising field is required.

PERMALLOY 'D'
for very high resistivity without undue lowering of the maximum flux density. Variation of permeability with frequency is small. Ideal for H.F. applications.

PERMALLOY 'F'
very rectangular hysteresis loop with a rententivity of at least 95% of its saturation value; high flux density and low coercive force. Ideal for saturable reactors, magnetic amplifiers, digital computers, memory devices, etc.

V-PERMENDUR
for high permeability with a very high value of maximum flux density. Finds special application for use as high quality receiver diaphrams, also motor generators and servo-mechanisms in aircraft where weight and volume are important factors.

PHYSICAL PROPERTIES AND GENERAL MAGNETIC CHARACTERISTICS

	Permalloy 'B'	Permalloy 'C'	Permalloy 'D'	Permalloy 'F'	V-Permendur
Specific Gravity	8.3	8.8	8.15	8.4	8.2
Electrical resistivity—microhms per cm cube	55	60	90	25	25
Initial permeability μ_o	2 000 to 4 000	15 000 to 40 000	1 800 to 3 000	400 to 1 000	700 to 1 000
Maximum permeability μ_{max}	15 000 to 40 000	50 000 to 150 000	12 000 to 20 000	200 000 to 400 000	3 000 to 6 000
Magnetising force for μ_{max}-oersteds	0.20 to 0.40	0.025 to 0.04	0.2 to 0.5	0.03 to 0.10	2.0 to 6.0
Maximum flux density-gauss	16 000	8 000	13 000	14 000	24 000
Coercive force in oersteds for B_{max}—5 000 gauss	0.15	0.03	0.15	0.05*	2.3†
Remanence in gauss for B_{max}—5 000 gauss	4 000	3 500	3 500	13 500*	16 000†
Hysteresis loss in ergs/cc/cycle for B_{max}—5 000 gauss	160	40	200	220*	12 500†
Total loss in watts/lb for B_{max} — 5 000 gauss 50 c/s 0.015 in. sheet	0.11	0.04	0.2	0.3*	4†

* for B_{max} — 14 000 gauss † for B_{max} — 20 000 gauss

Write for Technical Data Sheets :—

COMPONENTS GROUP

Standard Telephones and Cables Limited

Registered Office: Connaught House, Aldwych, London, W.C.2

MAGNETIC MATERIALS SALES DEPT: EDINBURGH WAY · HARLOW · ESSEX

6J/1MM

EE 30 074 *for further details*

DEFT FINGERS assemble transistors and diodes at new NEC semiconductor plant.

An NEC semiconductor device for every circuit application

The range of semiconductor products at NEC is perhaps the widest of any manufacturer. Entertainment or industrial, standard broadcast frequencies to microwave – NEC has a semiconductor device with the ratings and characteristics for your application. There's a wide selection of current ratings, operating temperatures, and mountings.

These are produced in NEC's new semiconductor plant where crystal surfaces are cleaned by 100 tons of hyper pure water daily. Every seal is tested in krypton isotopes, providing a failure rate suitable for the most critical applications.

A single source for semiconductors can mean a saving in time and costs. Just let NEC know your requirements and full technical data will be sent.

Types of NEC semiconductor devices

· PNP super-grown Germanium transistors · Germanium photo transistors · PNP alloy junction Germanium transistors · Silicon Mesa transistors · Germanium Mesa transistors · Germanium gold-bonded diodes · Silicon rectifiers · Silicon controlled rectifiers · Silicon capacitors · Zener diodes · Germanium point-contact mini-diodes · Silver-bonded diodes · Microwave mixer diodes · Silicon junction mini-diodes

Communications System / Electronic Components

NEC *Nippon Electric Co., Ltd.*

Tokyo, Japan

STC THERMAL DELAY SWITCHES

For the following operations:—

- Delay in switching on high tension supplies
- V.L.F. Oscillator
- Auto-reset circuit breaker
- Motor-starting

ABRIDGED DATA

Type	Delay at 20°C Min.	Max.	Heater Voltage
S.102 1G*	44	66	6·3
S.102 1K	44	66	6·3
S.103 1K	36	54	27
S.104 1K	25	35	6·3
S.105 1K	20	30	27
S.106 1K	44	66	19

* Flying Lead Version

Ask for application report MS 117

COMPONENTS GROUP

Standard Telephones and Cables Limited

Registered Office: Connaught House, Aldwych, London W.C.2

VALVE DIVISION: FOOTSCRAY SIDCUP KENT

EE 30 076 *for further details*

Electron gun, filament and bias supply

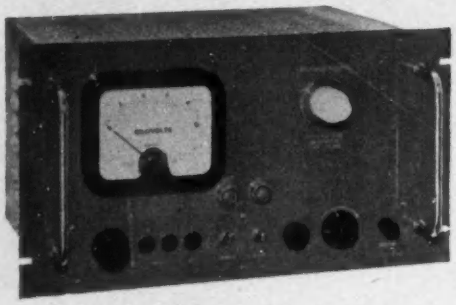
Input 200/250 volts, single phase.
Output 4 to 50 kV. at 0·25 mA. Positive grounded.
Regulation better than 0·5%, zero to full load.
Stability better than 0·02%, mains variation ±7%.
Ripple less than 1 part in 10^4 at 50 kV.
Filament output 6 volts at 3 amps. max., stabilised to 1%.
Output impedence 0·6 ohms.
Bias supply 22-step high stability potentiometer (both isolated for 50 kV. working).
Metering voltage and current metered with E.T. Model 705.
Presentation 4′ instrument rack.

Current stabilised lens supplies

Input 200/250 volts, single phase.
Output two separate supplies for objective and condenser lenses of 10 to 160 mA. into 600 ohms load, fitted with coarse and fine controls.
Stability 1 part in 10^4 over 15 minutes.
Presentation 19″ × 10½″ P.O. panel for rack mounting.

Scintillation and proportional counter supply

Input 200/250 volts, single phase.
Output 2·2 kV. at 3 mA.
Stability better than 0·1% for ±7% mains change.
Effective resistance less than 1000 ohms.
Ripple less than 12 mV. peak to peak.
Long-term drift less than 0·1% over 24 hours.
Metering input to potentiometers monitered by E.T. Model 703.
Potentiometers two fitted, giving outputs 500 volts to 2 kV. with coarse and fine controls.
Construction 19″ × 7″ P.O. panel, enclosed for rack mounting or bench use.

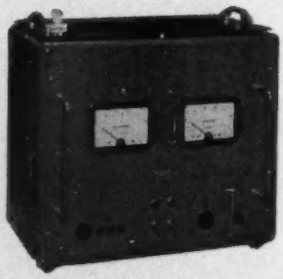


5, 10, 20 and 30 kilovolt regulated supply

Type So530
Output 1 to 10 kV. at 2 mA. Model A 2. to 20 kV. at 1 mA. Model B. 3 to 30 kV. at ½ mA. Model C. 500V. to 5 kV. at 2 mA. Model D.
Input 200/250 volts, 50 cycles.
Polarity positive or negative grounded available.
Regulation against full load: better than 0·5%.
Against mains variations ±7%, better than 1%.

- 5″ Ernest Turner movement.
- current metering jack.
- standard 19″ × 10½″ P.O. panel, for rack mounting or bench use.

£135 *ex-works*
Models A, B and C can be supplied with reversible output polarity at £165



50 kilovolt regulated supply

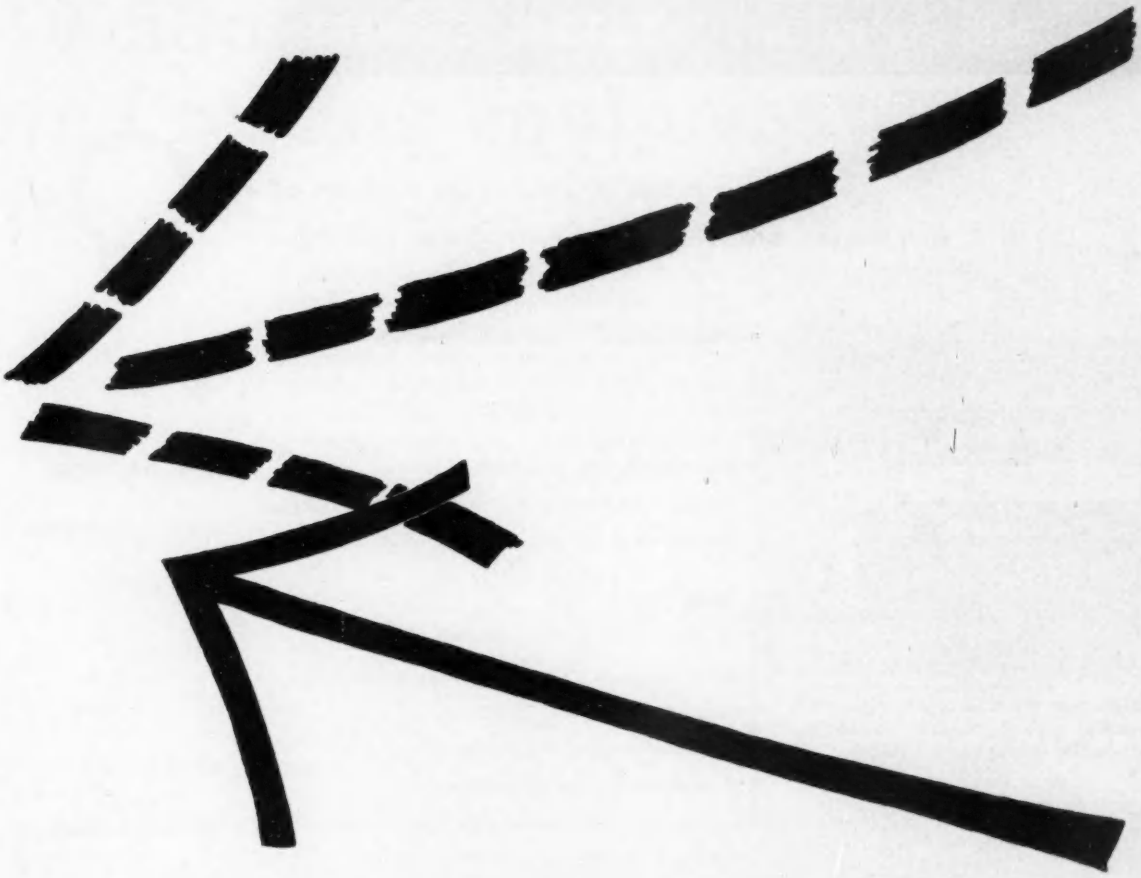
Type MR50R
Output 5 kV. to 50 kV. at 1 mA.
Input 200/250 volts.
Polarity reversible.
Regulation against full load: better than 1%.
Against mains variations: +5%, −5%, better than 1%.
Dimensions W: 24″ H: 23″ D: 15″.
£245 *ex-works*

Brochure on request
For further specifications of the Brandenburg range of equipment, please write for brochure.

Brandenburg Limited

139 Sanderstead Road, South Croydon, Surrey. Sanderstead 3555-6
Prices quoted are for U.K. only
Export enquiries to: Applied Research (Instruments) Ltd., Emefco House, Reigate, Surrey, England.

EE 30 077 *for further details*



Chosen for the most advanced equipment . . .

Brandenburg Limited manufacture all the Power Supplies for the Scanning *X*-ray Microanalyser, a revolution in metallurgical analysis, made by the Cambridge Instrument Company Limited. The Brandenburg equipment includes: a 50 kV. highly stable electron gun supply with a regulated transistorised filament and variable bias supply, both working at 50 kV. A current-stabilised lens supply, with double output. A variable twin-output 2.2 kV. counter supply. And a composite regulated H.T. power pack.

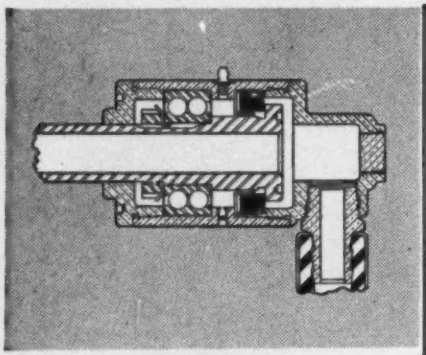
regulated POWER SUPPLIES

Brandenburg

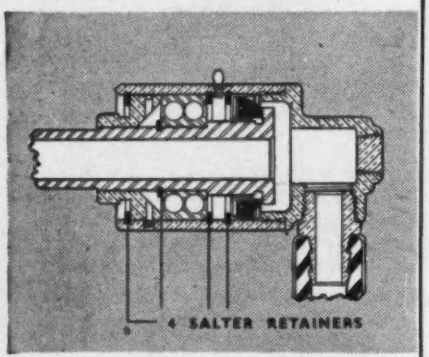
EE 30 078 *for further details*

How costs are cut with **SALTER** RETAINERS

Salter retainers simplify design of air, water, steam union, with great savings



THE OLD WAY Air, water, steam union involved drilling, threading and milling operations. Maintenance was difficult.



THE SALTER WAY Salter retainers permit rapid, simple assembly and maintenance with a reduction in manufacturing costs.

MATERIALS SAVED	
decreased wall thickness of housing	2/9¾
eliminated bearing lock nut and washer	7¾
MACHINE OPERATIONS ELIMINATED	
bore, undercut, and tap cap end of housing	1/4¾
locate cap on arbor, and chase threads	1/-
drill spanner wrench holes	4¼
cut thread on rotor for lock nut	3¾
mill slot in thread for tang on lock washer	7½
drill spanner wrench holes in rotor	4¼
ASSEMBLY OPERATIONS ELIMINATED	
install lock washer, tighten lock nut, bend lug	8½
assemble cap into housing	4
TOTAL SAVING WITH SALTER RETAINERS	8/6½

*

4 SALTER RETAINERS simplify design, assembly and maintenance with a saving of 8/6½ per unit

NEATER – MORE POSITIVE – PERMANENT RETAINING

SALTER "TRUARC" Regd. Trade Mark

Circlips Fasteners Retainers Fixes

Geo. Salter & Co. Ltd., West Bromwich. Spring Specialists since 1760

H-W.481

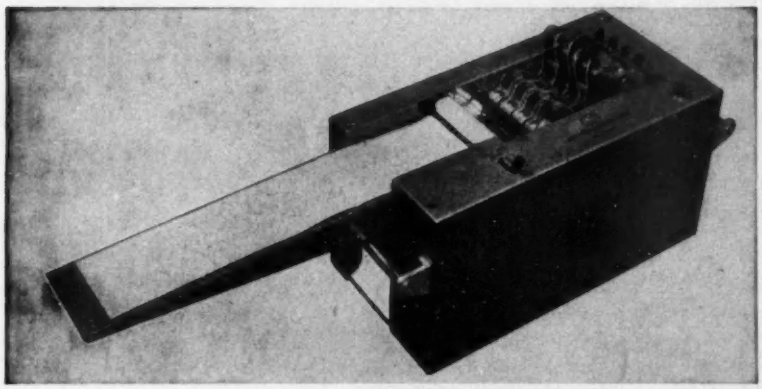
Oscillographic recording and testing equipment from Siemens Ediswan

If your work involves the study of fluctuating or intermittent phenomena, you should know more about these instruments.
The versatile High Speed Pen Recorder unit can be supplied singly or grouped in multiples of four up to a maximum of 16 channels and suitable amplifiers having a sensitivity of 1μV/mm a.c. or 10 mV/mm d.c. can also be supplied. These combinations are already making permanent economical records in industrial, physiological and physical research.

LOW FREQUENCY OSCILLATOR TYPE R.2125

The Low Frequency Oscillator is a general purpose R.C. instrument designed for testing, calibrating and setting up amplifiers, recorders, and low frequency wave analysers.

Frequency Range	1 c/s to 132 Kc/s
Frequency accuracy	2%
Output	Balanced push pull, 50 volts p.p. maximum on open circuit.
Attenuator	5 x 20 dB steps plus 0—20 dB continuously variable.
Output Impedance	600Ω—0—600Ω

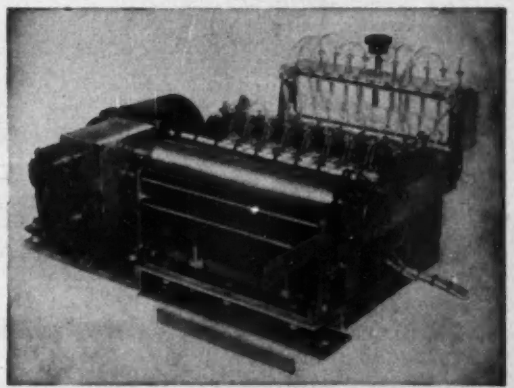


PORTABLE RECORDER TYPE EPR

The Siemens Ediswan pen oscillograph is a portable 1 to 4 channel, high speed, direct ink writing, recorder.
The pen motor coil is 1450 ohms centre tapped.
Frequency response within 10% from 0–70 c.p.s.
Pen motors can be supplied with coil resistances of 230 ohms for use with transistors.
Maximum deflection of pen tip 4 cms peak to peak.
An electrical time and event marker is provided, writing on the lower edge of the paper.
The 4" wide paper is driven by a rubber covered capstan roller and speeds of 0·75 cms/sec. to 12 cms/sec. can be obtained.

8 CHANNEL PEN RECORDER UNIT

The pen motors incorporated in this unit are identical to those used in the 4 channel pen oscillograph.
The unit includes 8 pen motors fitted into a magnet block, two time markers, ink system and paper drive mechanism.
Three speeds of 1·5, 3 and 6 cms/sec. are available.
The unit is offered as shown in the photograph and is intended for incorporation into the users own equipment.
A 16 channel version of the above unit is also available.



We shall be pleased to send you particulars of these products

AEI

Associated Electrical Industries Ltd
Radio and Electronic Components Division
PD 17, 155 Charing Cross Road, London WC2
Tel: GERrard 8660. Telegrams: Sieswan Westcent London

CRC 17/19

the ULTIMATE in radio frequency connectors . . .

OVER 200
TYPES AVAILABLE!

TRANSRADIO LTD

138A CROMWELL ROAD LONDON SW7 *Telephone:* FREmantle 4421 (P.B.X.)

* *Immediate deliveries from stock - you can rely on TRANSRADIO SERVICE!*

✳ CO-AX cables
Airflex cables
RG cables
Minicables

✳ ULTRA LOW
CAPACITANCE & ATTENUATION

38 STOCK TYPES
for your
standard or special
applications

TYPE	F.H.	IMPED	O.D
C1	7.3	150	.36
C11	6.3	173	.36
C2	6.3	171	.40
C22	5.5	184	.44
C3	5.0	197	.64
C33	4.8	220	.64
C4	4.6	229	1.03
C44	4.1	252	1.03

TRANSRADIO LTD

138A CROMWELL ROAD LONDON SW7 *Telephone:* FREmantle 4421 (P.B.X.)

✳ *24 hour delivery service - you can rely on TRANSRADIO SERVICE!*

EE 30 062 *for further details*

Xeronic High-Speed Printer used by British Industry. An artist's impression

Rank Precision Industries Limited specify Electrosil

The Xeronic High-Speed Computer Output Printer, for use in conjunction with electronic computers, has been designed and developed by Rank Precision Industries Limited, who specified 'Electrosil' metal oxide film resistors. No normal method of printing can keep up with the very fast output of the many modern electronic computers designed for data-processing applications. The Xeronic High Speed Output Printer, however, employs the principle of xerography, in which the photo-conductive properties of selenium are used to convert an optical image into printing on plain, unprepared, unsensitized paper. Working with the computer, the Xeronic Printer achieves speeds of up to 48 lines per second of clear, readable characters. It will print its own forms; tabulate, both horizontally and vertically; can suppress information; and its associated apparatus will cut and stack documents automatically at a speed comparable to that of the printing.

'Electrosil' metal oxide film resistors have been developed for high-quality applications, giving *higher performance *greater stability—under the most adverse conditions, *especially where stability and reliability must be long-term.*

Style N high stability resistors

Stability: resistance change after 2,000 hours operation at 70°C with a constant DC voltage, calculated from the nominal resistance and rated wattage for this temperature subjected to the specified voltage limitations: better than ±0.25%.

Overload: standard 5-sec. overload of 6.25 times rated power causes a permanent resistance change of less than 0.75%.

Voltage co-efficient: negligible, averaging less than 0.001%.

Noise: extremely low level, averaging less than .015 micro volts per volt.

Style P insulated power resistors are also available for radio, television and allied uses.

Electrosil

METAL OXIDE FILM RESISTORS

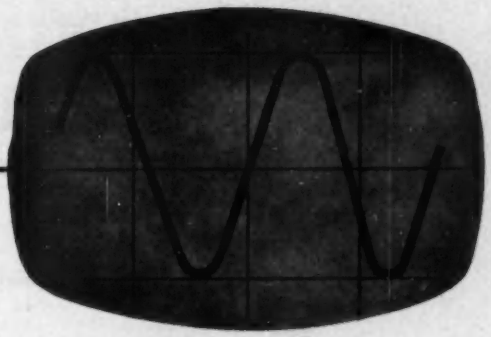
Further information on request to:

Electrical Sales Department

JAMES A. JOBLING & CO. LTD

Wear Glass Works, Sunderland. Tel. 57251

STABILIZED SINUSOIDAL VOLTAGE



by *Advance*

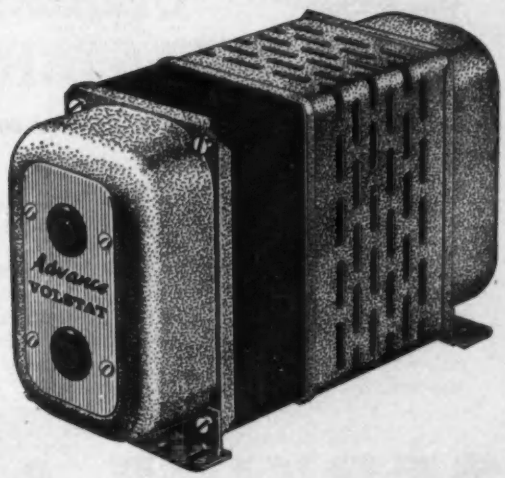
the CVH RANGE VOLSTAT

Advance constant voltage transformers are available in the CVH range with low harmonic distortion in the output waveform, ideal for use with precision equipment sensitive to power frequency harmonics, and also with all equipment requiring a constant voltage sinusoidal input.

In most applications the harmonic distortion present in the output waveform will not exceed 3%. Under the most unfavourable conditions this figure will not rise substantially above 5%. When used with a rectifier to provide a d.c. supply, the characteristics of the system are identical to the normal mains source and particularly close regulation of the output is obtained.

- CONTINUOUS AND AUTOMATIC STABILIZATION
- RAPID RESPONSE TIME
- CURRENT LIMITING CHARACTERISTIC
- COMPACT DESIGN
- NO MOVING PARTS
- NO ROUTINE MAINTENANCE

Type	I/P V Range	O/P V r.m.s.	Watts	p.f.	Nett Price in U.K.
CVH 60A	190-260 50~	240	60	1·00	£10 10 0
CVH 125A	190-260 50~	230	125	1·00	£17 0 0
CVH 420A	190-260 50~	230	420	1·00	£37 0 0
CVH 750A	190-260 50~	230	750	1·00	£68 0 0
CVH 1500A	190-260 50~	230	1500	1·00	£99 0 0
CVH 3000A	190-260 50~	230	3000	1·00	£185 0 0
CVH 6000A	190-260 50~	230	6000	1·00	£355 0 0



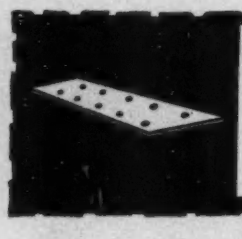
Advance COMPONENTS LIMITED

MAINS STABILIZATION DIVISION

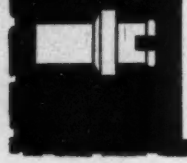
ROEBUCK ROAD • HAINAULT • ILFORD • ESSEX • TELEPHONE : HAINAULT 4444

IT/Da

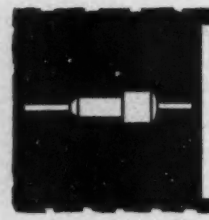
EE 30 084 *for further details*



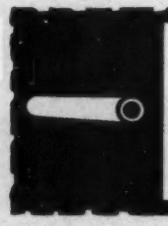
TERMINAL BOARDS



LUGS



MOULDED INSULATORS



CHASSIS FURNISHINGS

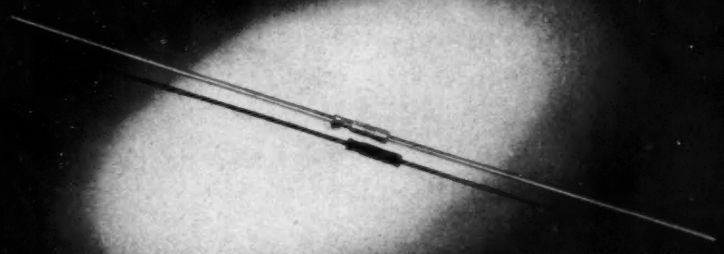
FIRST

Harwin *make* components—*specialise* in components. Lugs, moulded insulators, terminal boards and chassis furnishings. 'Off-the-shelf' or to special design.
The *quality* of every Harwin component is the product of experienced, precision manufacture and rigid inspection—meeting, and in many cases surpassing standard specifications. In addition, Harwin *service* and *specialisation* in fulfilling individual needs is something to be experienced—talk over *your* component problems with Harwin and be sure of the *best* and most *effective* answer.

SERVICE AND QUALITY

HARWIN ENGINEERS LTD RODNEY ROAD PORTSMOUTH · HAMPSHIRE · Tel: Portsmouth 35555 (4 lines)

how miniature can miniature get?



Actual-size illustration of our Super Sub-Miniature range of capacitors. This one has 2 mfd at 6 volts. It is ·080" diameter and $\frac{11}{32}$" in length.

The manufacture of this Super Sub-Miniature electrolytic capacitor from super-pure (99·99%) anode materials and featuring our exclusive welded wire termination, is a fair indication of the standard of craftsmanship that we offer throughout a wide range of these approved components. The full range includes more than one hundred. A few of them are listed below for your information.

Maximum Capacitance MFD	Working Voltage	Size (Diameter)	Size (Length)
20	6	$\frac{1}{8}$"	$\frac{5}{16}$"
30	3	$\frac{1}{8}$"	$\frac{5}{16}$"
8	6	·1"	$\frac{3}{8}$"
10	3	·1"	$\frac{3}{8}$"
5	6	·1"	$\frac{13}{32}$"
7	3	·1"	$\frac{13}{32}$"
2	6	·08"	$\frac{11}{32}$"
3	3	·08"	$\frac{11}{32}$"

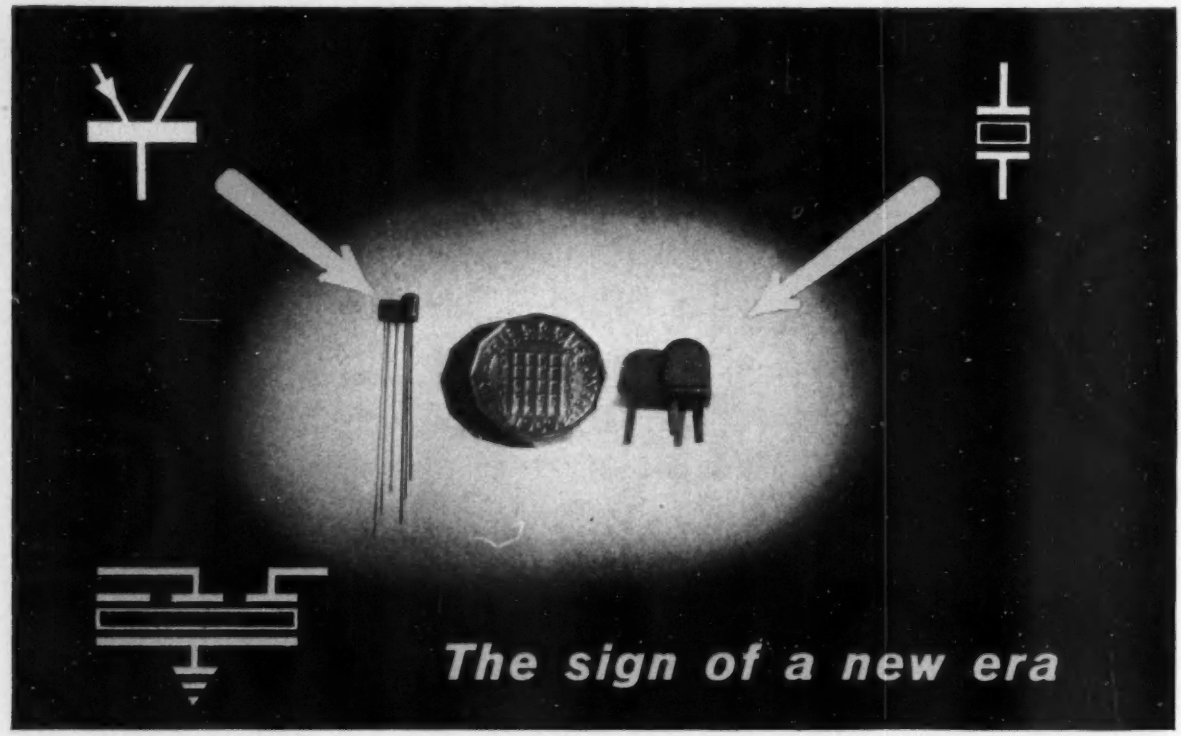
All Capacitors have
WELDED WIRE TERMINATIONS — Patent applied for

S

SWINDON CONDENSER COMPANY LIMITED

Industrial Estate, Swindon, Wiltshire
Tel: Swindon 6751/2

EE 30 086 *for further details*



A ceramic filter element with impedance coupling properties! Utilizing the piezo-electric effect in lead zirconate titanate ceramic, the TRANSFILTER* provides a low-impedance highly-selective tuned circuit especially suitable for i.f. circuits and filter applications.

The Brush 'Clevite' TRANSFILTER combines ideally with transistors in the trend for miniaturization. Designed for use with printed circuits, the TRANSFILTER requires no initial or periodic frequency alignment and is unaffected by shocks exceeding 100 g or temperatures up to 200°C.

Write for the TRANSFILTER leaflet, which gives details of types available for 455, 465 and 500 kc/s operation in interstage coupler or emitter by-pass applications.

*Reg'd. Trade Mark

BRUSH
CRYSTAL CO. LTD.
CERAMICS

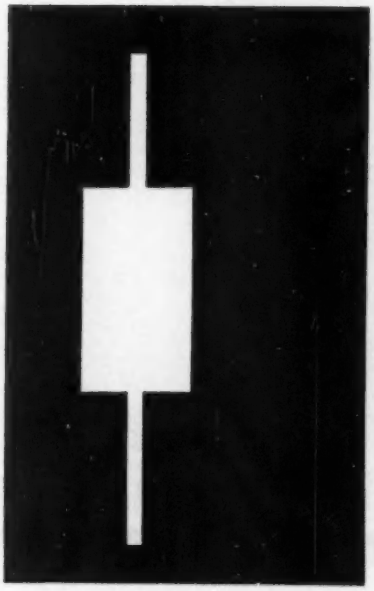
HYTHE · SOUTHAMPTON · HANTS · Phone: HYTHE 3031

EE 30 087 *for further details*

The Plessey E.R.F. range of encapsulated r.f. inductors was designed for utmost reliability in use. Completely sealed in Plaskon Alkyd, Plessey inductors withstand the toughest usage. Vibration, bump, pull and twist of leads, humidity and temperature cycling . . . Plessey inductors meet these menaces with the appropriate quality approval specifications. Proof of efficiency lies in the present general use of these components by British and NATO ground Service communications equipments. Whatever the job, wherever the job, you'll find it pays to specify a Plessey component.

Plessey

e.r.f. inductors *withstand vibration, temperature extremes*



For further information, specifications etc., on Plessey E.R.F. inductors contact:

Components Group,
Industrial/Electronic Component Sales

THE PLESSEY COMPANY LIMITED · Ilford · Essex · Telephone: Ilford 3040

Overseas Sales Organisation:
PLESSEY INTERNATIONAL LIMITED

IEC7B

EE 30 088 *for further details*

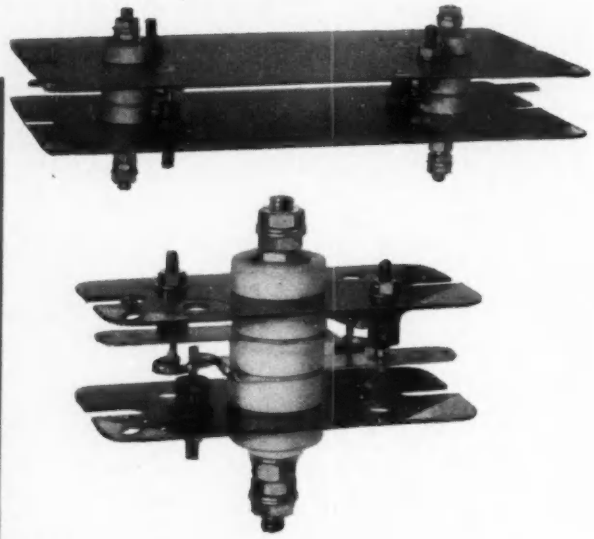
BRADLEY

BRIDGE RECTIFIERS

INCORPORATING LUCAS SILICON DIODES

A new range of silicon rectifiers, suitable for single-phase full-wave bridge operation. Available in 2A, 7A, 12·5A and 20A stacks, each with peak inverse voltage ratings of 50, 100, 200 and 400 volts.

Model No.	Dimensions (inches)	P.I.V.	Max. Input volts (R.M.S.)	IDC (Amps) at 25° C.	Max. Ambient Operating Temp. °C.
IB320A	1½×3×2¾	50	35	2·0	150
IB321A	1½×3×2¾	100	70	2·0	150
IB323A	1½×3×2¾	200	140	2·0	150
IB326A	1½×3×2¾	400	280	2·0	150
IB320B	3 ×6×2¾	50	35	2·0	150
IB321B	3 ×6×2¾	100	70	2·0	150
IB323B	3 ×6×2¾	200	140	2·0	150
IB326B	3 ×6×2¾	400	280	2·0	150
IB510A	1½×3×2¾	50	35	10·0	100
IB511A	1½×3×2¾	100	70	10·0	100
IB513A	1½×3×2¾	200	140	10·0	100
IB516A	1½×3×2¾	400	280	10·0	100
IB510B	3 ×6×2¾	50	35	18·5	100
IB511B	3 ×6×2¾	100	70	18·5	100
IB513B	3 ×6×2¾	200	140	18·5	100
IB516B	3 ×6×2¾	400	280	18·5	100
IB510C	4 ×8×2¾	50	35	20·0	100
IB511C	4 ×8×2¾	100	70	20·0	100
IB513C	4 ×8×2¾	200	140	20·0	100
IB516C	4 ×8×2¾	400	280	20·0	100



LUCAS

GEB

Joseph Lucas Ltd

For further information and prices—apply to

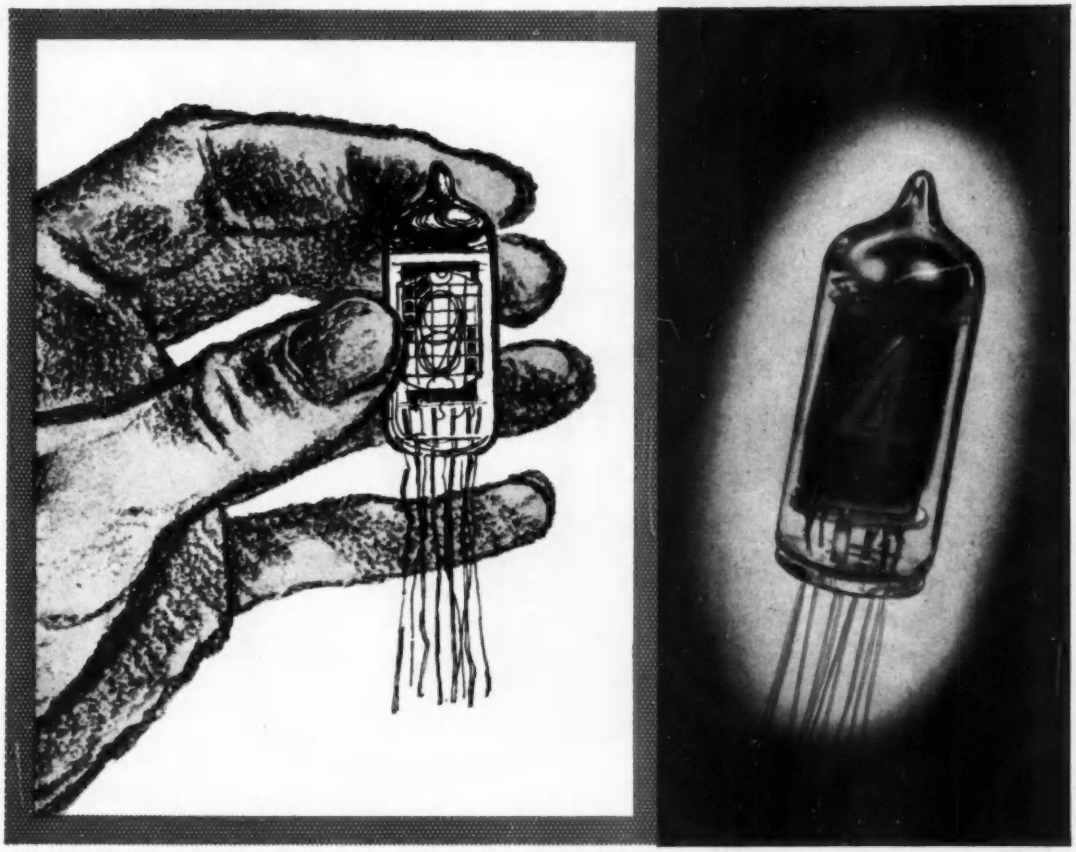
G & E Bradley Ltd

SEMI-CONDUCTOR DIVISION. *Telephone* Gladstone 0012
ELECTRAL HOUSE, NEASDEN LANE, LONDON, N.W.10.

A Subsidiary Company of Joseph Lucas (Industries) Ltd.

EE 30 089 *for further details*

HIVAC NUMICATOR



miniature, in-line, digital display tube

* Miniature *side viewing* tubes for the most compact numerical presentation. Flying lead connections for maximum conveniences and reliability.

* Available with numerals from 0 to 9. Fractions, plus and minus signs and special symbols are also possible.

* All digits appear *in the same position*, as seen from the front. Numicators accordingly offer the very great advantage of in-line display.

* Hivac Numicators have all the normal advantages of neon indicator lamps—low consumption, low temperature operation, and freedom from risk of sudden failure.

N.1

Our specialised experience in the design and manufacture of cold cathode tubes and neon indicators ensures the high quality, consistency and long operating life of Hivac Numicators. They can be operated in a variety of ways: from cold cathode tubes or from mechanical and electromechanical switches.

HIVAC LIMITED

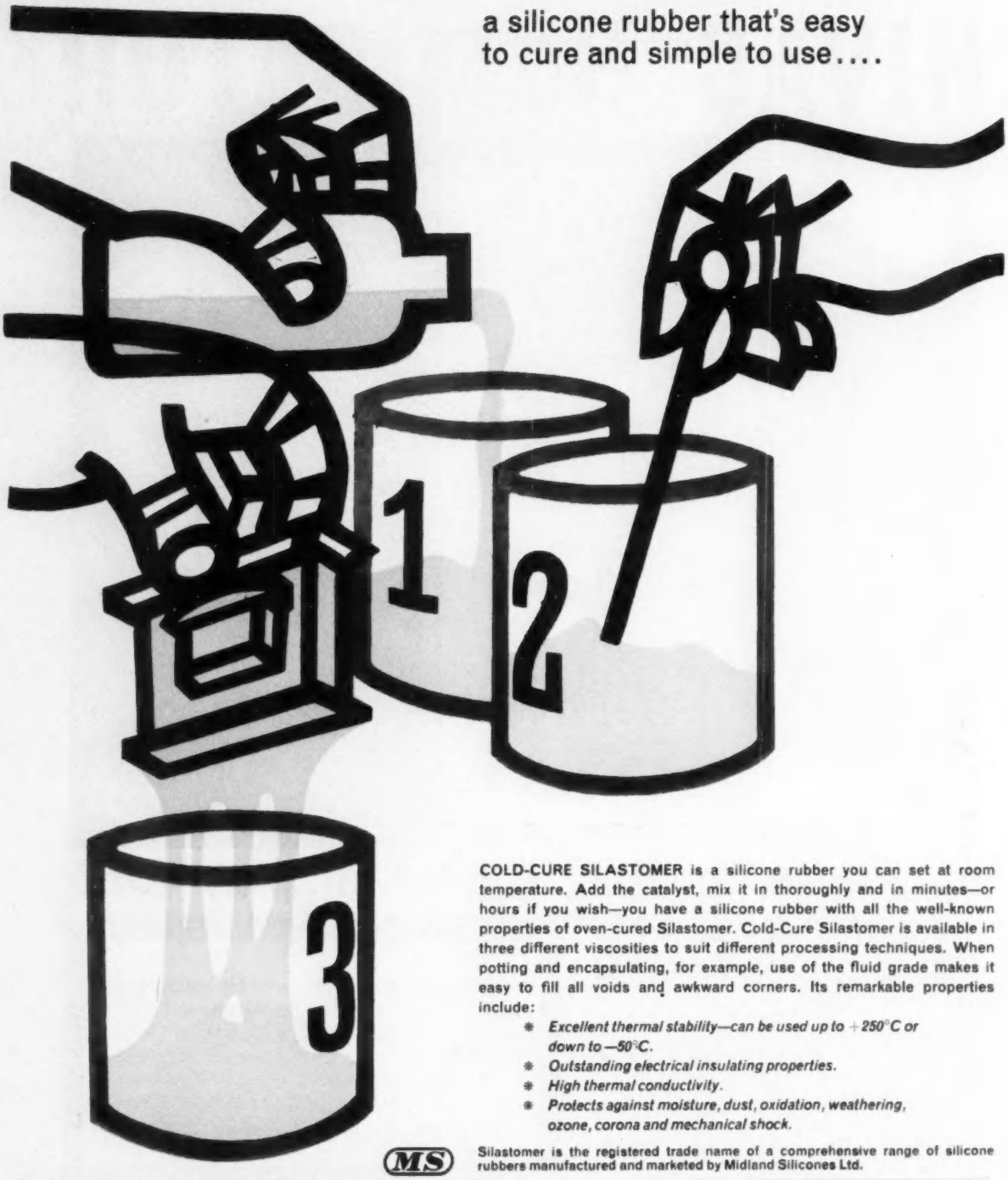
STONEFIELD WAY · SOUTH RUISLIP · MIDDLESEX · Telephone: VIKING 1288

A member of the A.T. & E. Group

EE 30 090 *for further details*

IN A THRICE!

a silicone rubber that's easy to cure and simple to use....



COLD-CURE SILASTOMER is a silicone rubber you can set at room temperature. Add the catalyst, mix it in thoroughly and in minutes—or hours if you wish—you have a silicone rubber with all the well-known properties of oven-cured Silastomer. Cold-Cure Silastomer is available in three different viscosities to suit different processing techniques. When potting and encapsulating, for example, use of the fluid grade makes it easy to fill all voids and awkward corners. Its remarkable properties include:

- *Excellent thermal stability—can be used up to +250°C or down to —50°C.*
- *Outstanding electrical insulating properties.*
- *High thermal conductivity.*
- *Protects against moisture, dust, oxidation, weathering, ozone, corona and mechanical shock.*

Silastomer is the registered trade name of a comprehensive range of silicone rubbers manufactured and marketed by Midland Silicones Ltd.

To give you information on all the properties and applications of Cold-Cure Silastomer, we have prepared a fully detailed and illustrated booklet. Please write or phone our nearest branch office for a copy.

MS

MIDLAND SILICONES LTD

(Associated with Albright & Wilson Ltd. and Dow Corning Corporation)

***first** in British Silicones*

68 Knightsbridge, London, SW1. Telephone: Knightsbridge 7801.

Area Sales Offices: Birmingham, Glasgow, Leeds, London, Manchester
Agents in many countries

MSRB

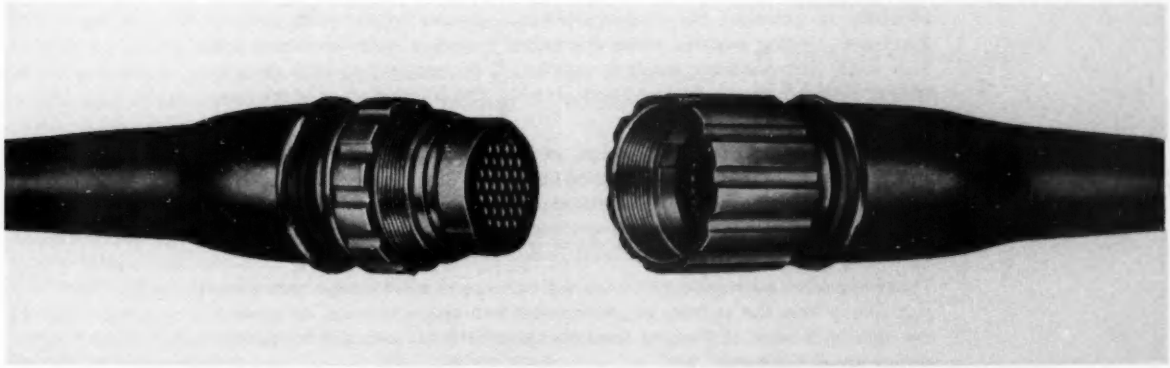
BICC

polypole couplers

for Pye microwave TV links

Robust, reliable and lightweight BICC Polypole Couplers and Multicore Cables are used exclusively by PYE as part of the standard equipment for their transportable long range television links.

BICC design and manufacture Polypole Coupler Systems to meet special requirements. These systems cover a wide variety of types and sizes of cable, terminated with moulded-on couplers.



Further information is contained in Publication No. TD TPC 5—available on request.

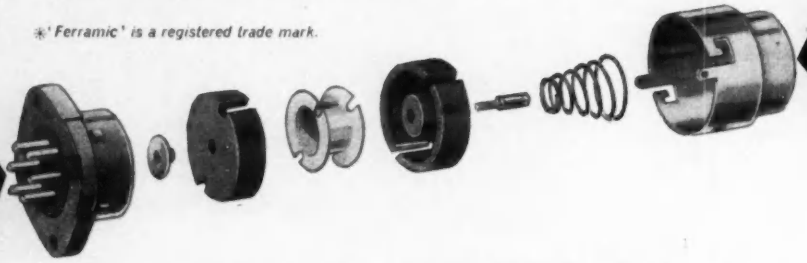
BRITISH INSULATED CALLENDER'S CABLES LIMITED 21 BLOOMSBURY STREET LONDON WC1

adjustable up to ±12½%

high Q Ferramic* T POT CORES

The immense research, development and manufacturing resources behind the Plessey Chemical and Metallurgical Division are freely available to users of all types of ferrite, dielectric and piezoelectric ceramic and semiconductor products; tantalum and other specialised capacitors. The Division's resources are backed by the accumulated 'know-how' of the entire Plessey Group of Companies and their associates.

*'Ferramic' is a registered trade mark.



Typical of the Division's leading position is this new range of Plessey pot cores, of 14, 18, 22 and 26 mm. diameter which offer a choice of four effective permeabilities in each size. The frequency range of the ferrites available covers 1 kc/s to 2 Mc/s. Adequate inductance variation with a fine setting accuracy is achieved by a non-projecting screwed adjustment system. Precision grinding ensures close tolerances in design parameters and the high initial permeabilities result in excellent Q factors (e.g. Q 1000 using a 26 mm. diameter core in T11) and high stability. The winding areas of the low-loss nylon bobbins are generous.

For the 14 and 18 mm. diameter cores, very compact "bayonet fitting" metal containers with printed circuit mounting tag boards (and alternative " chassis-mounting " fixing holes) are available which are easy and rapid to assemble. The combination of the higher permeability, and a more compact assembly without loss of stability means a really remarkable saving in volume.

These and other outstanding features will help you to solve design problems, particularly from the stability of performance and space aspects, so contact the specialist team of Plessey liaison engineers today and ask for further details about FERRAMIC T.

Plessey

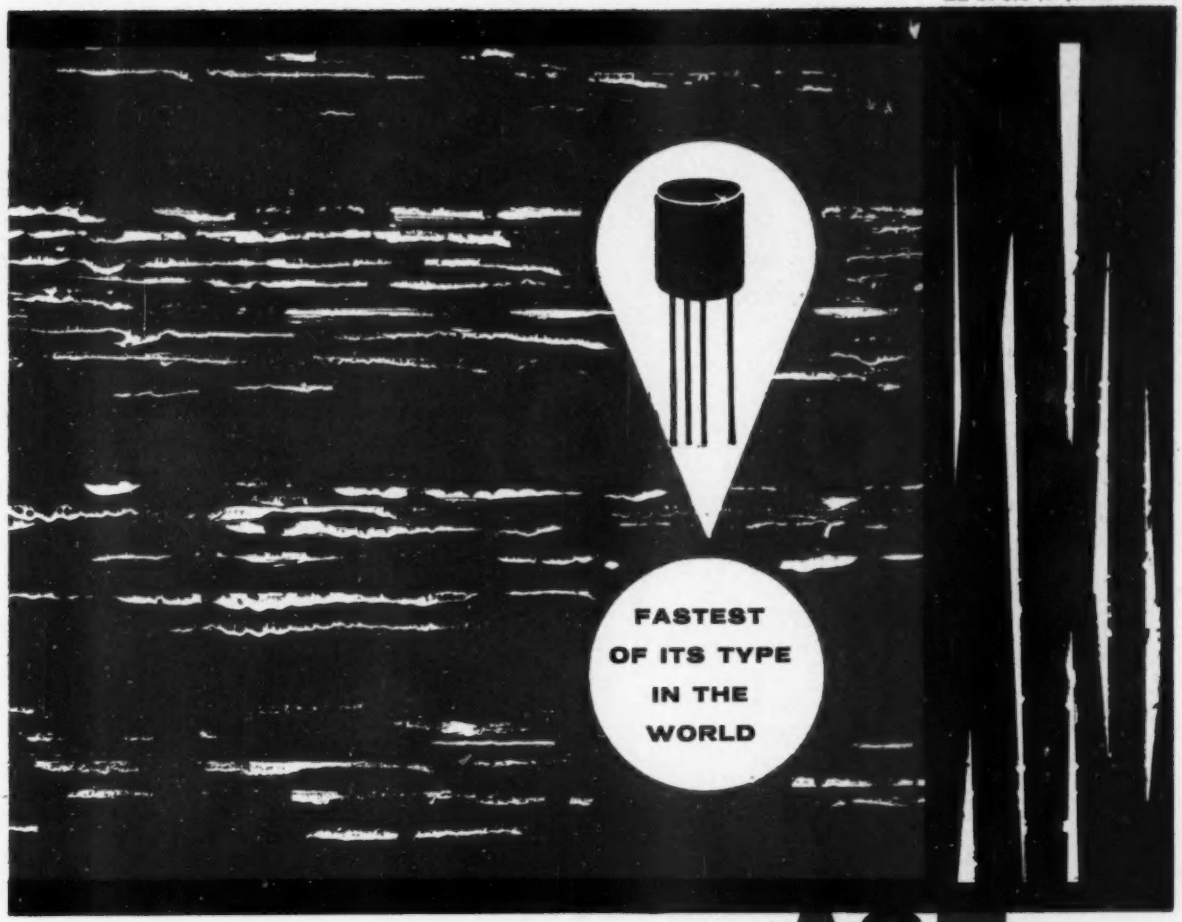
Components Group · CHEMICAL & METALLURGICAL DIVISION

The Plessey Company Limited

Wood Burcote Way · Towcester · Northants · Tel : Towcester 312/4

Overseas Sales Organisation: Plessey International Limited · Ilford · Essex · Tel : Ilford 3040

TC23



NEW MULLARD AVALANCHE TRANSISTOR

ASZ 23

Today you can specify a truly *dependable* avalanche junction transistor, for use in very high speed circuits. It is the Mullard ASZ23—a new *purpose-made* transistor that is manufactured by the Mullard alloy diffusion technique to give complete reliability of the avalanche mode. Mullard experience in the development of alloy diffused transistors has made possible the production of this high avalanche performance p-n-p junction transistor at a realistic price.

Here is a transistor to give the designer tremendous scope. The ASZ23 opens up a new field of nanosecond pulse techniques. A typical application is in the sampling oscilloscope circuit shown alongside.

Supplies of the ASZ23 are immediately available.

ASZ 23 Alloy Diffusion p-n-p Junction Transistor

Absolute Maximum Ratings

Collector current ic (pk) max	100 mA
Reverse emitter-base voltage V_{eb} max	−2.0 V

Temperature Ratings

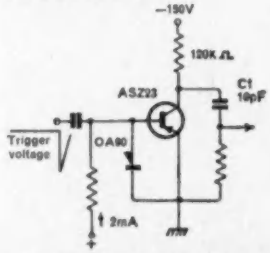
Storage temperature limits	−55 to + 75°C
Maximum junction temperature	75°C
Junction temperature rise above ambient	0.6° C/mW
Junction temperature rise above case	0.5° C/mW

Typical Characteristics

at T junction=25°C	
V_{cb} turnover at I_{co}=1mA, Ie=0,	−24V
Rise time of output pulse in circuits shown	1ns

● *If you would like more detailed information, please write to the address below:*

60 mA pulse with rise time of 1 nanosecond



A typical method of obtaining a predetermined sampling pulse by means of the ASZ23.

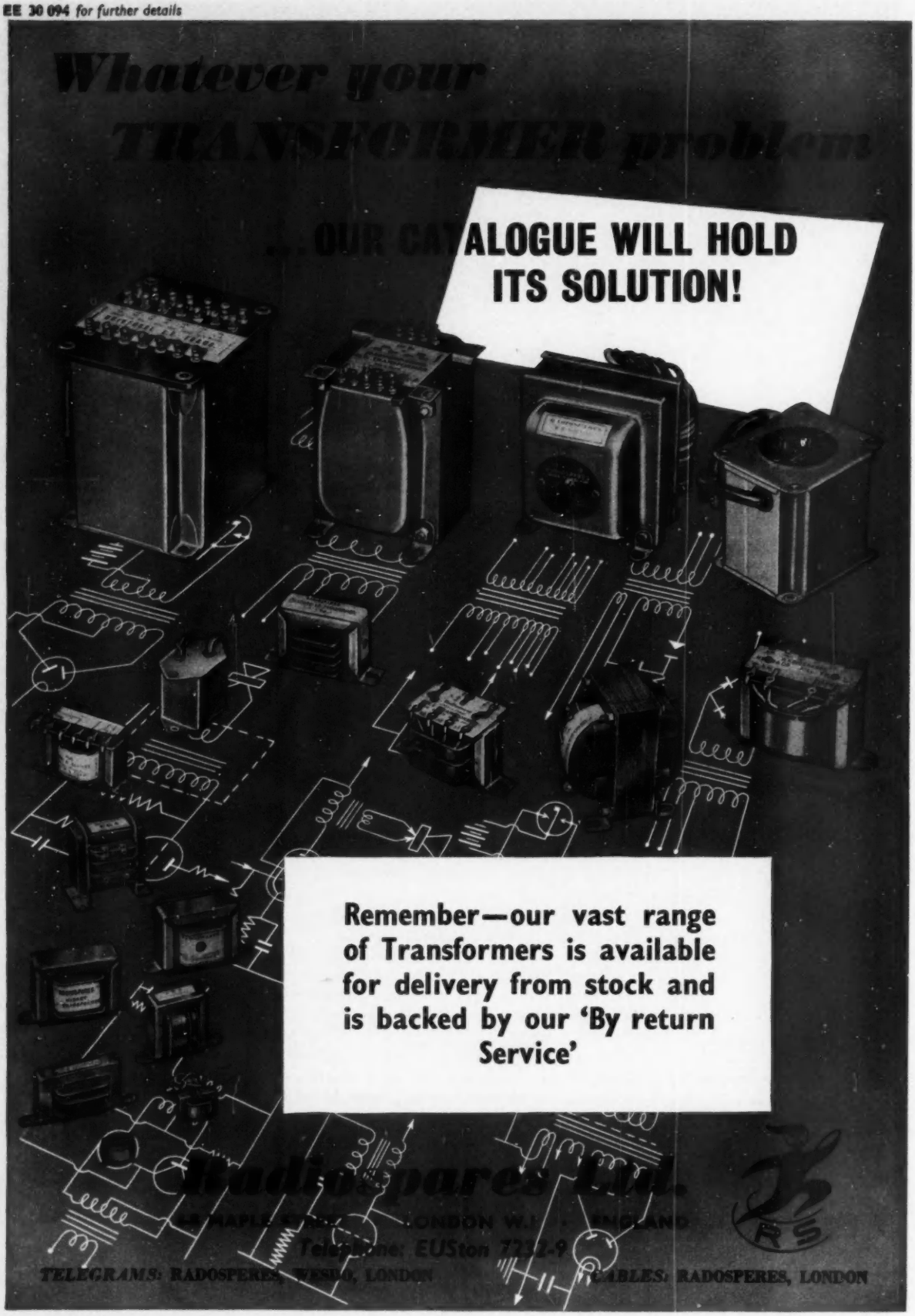
Mullard — *another* ***ALLOY DIFFUSION*** *transistor*

Mullard
semiconductors
for industry

MULLARD LTD · SEMICONDUCTOR DIVISION · MULLARD HOUSE · TORRINGTON PLACE · LONDON WC1 · Tel: LANgham 6633

M1530

EE 30 094 *for further details*


Whatever your
TRANSFORMER problem
...OUR CATALOGUE WILL HOLD
ITS SOLUTION!
Remember—our vast range of Transformers is available for delivery from stock and is backed by our 'By return Service'
Radiospares Ltd.
Telephone: EUSton 7232-9
TELEGRAMS: RADOSPERES, WESDO, LONDON
CABLES: RADOSPERES, LONDON

specify

diodes

Hughes HS10 series are low cost alloyed junction silicon diodes characterized by good forward conductance and low reverse current at high temperatures.

Made in Glenrothes, Scotland, the Hughes range of silicon and germanium diodes are subminiature devices with extremely stable electrical and mechanical characteristics. These diodes are specially designed and constructed to meet the most exacting requirements of military or commercial applications. They are double wire ended and fusion-sealed in a subminiature one-piece glass envelope to ensure complete isolation of the active elements from damage or contamination. The small size, combined with rigidity of construction and small mass of the elements, enable them to withstand successfully physical shock and vibration.

LOW REVERSE LEAKAGE + SMALL SIZE + DOUBLE ENDED + LOW CAPACITANCE

+ RELIABILITY + IMMEDIATE AVAILABILITY + LOW COST = **HS10** SERIES

Qualified engineers in our Research and Development laboratories at Glenrothes are available to help with your application problems.

Home and overseas enquiries to:

HUGHES INTERNATIONAL (U.K.) LTD

KERSHAW HOUSE, GREAT WEST ROAD, HOUNSLOW, MIDDLESEX · HOUNSLOW 5222

SOLARTRON

RANGE OF OSCILLATORS

TO COVER 0.01 c/s—50 Mc/s

An extremely wide frequency spectrum to embrace countless applications requiring low distortion sine-waves of stable frequency and amplitude.

R—C OSCILLATOR—CO 1004

With a frequency range suitable for Audio and R.F. applications.

10 c/s—1 Mc/s, accurate to ±2.5%. 2 phases—0° and 180°: 0—20 V r.m.s. Distortion: <1% in 20 c/s—200 Kc/s, <2% outside these limits. Hum and noise 0.2% of V_{out}.

servo sub-sonic

TWO PHASE L.F. OSCILLATOR BO 567

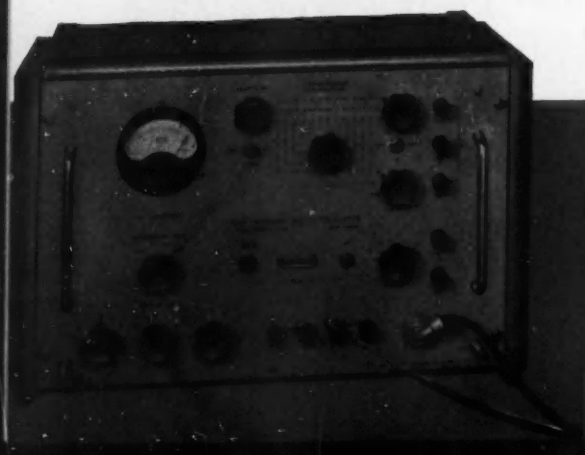
For vibration investigations, servo excitation and L.F. applications.

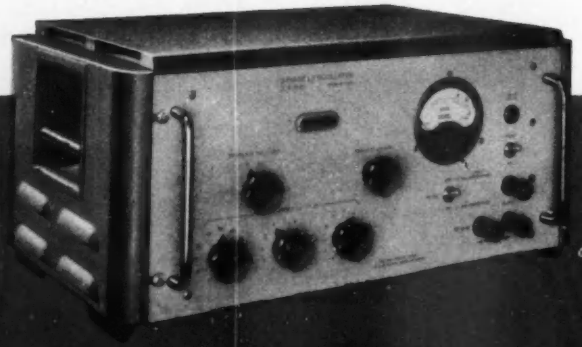
0.1 c/s—1.11 Kc/s, accurate to ±2%. 2 phases—0° and 90° (± 1° accuracy), 10 V r.m.s., 12 mA r.m.s. max. current. Distortion <2%.

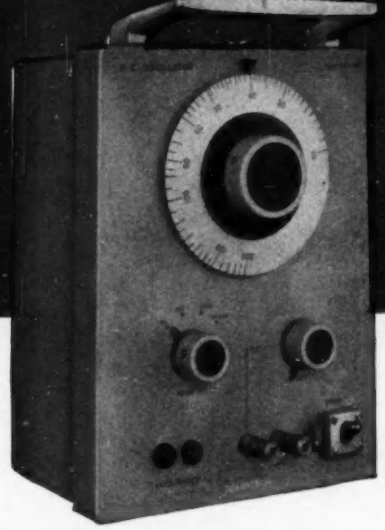
LOW FREQUENCY DECADE OSCILLATOR OS 103.2

Specially designed for Servo and Transfer Function Analysis or applications involving Sub-Audio and Audio frequencies.

0.01 c/s—11.1 Kc/s, accurate to ±1.5%. 4 phases—0° and 180°: 10 mV—10 V r.m.s., 90° and 270° (reference only): 10 V. Phase accuracy to ±1°. Distortion approx. 1%.
When used with the Solartron LF Resolved Component Indicator (VP 253.2) the system is known as Transfer Function Analyser which indicates a vector quantity by cartesian co-ordinate presentation.







PORTABLE R—C OSCILLATOR—CO 1008

Transistorised, operating from internal batteries.

20 c/s—200 Kc/s, accurate to ±5%. Frequency stability: 0.2% over 8 hour period. Amplitude stability ±2% over full frequency range. Output: 0—1 V r.m.s. Distortion < 0.25% in 100 c/s—200 Kc/s, < 1% outside these limits (for battery range 18—14 V). Noise < 0.1% of max. output. Useful battery life 3 months.

WIDE RANGE OSCILLATOR—CO 546

For amplifier and network testing or design, also suitable for a.c. bridges.

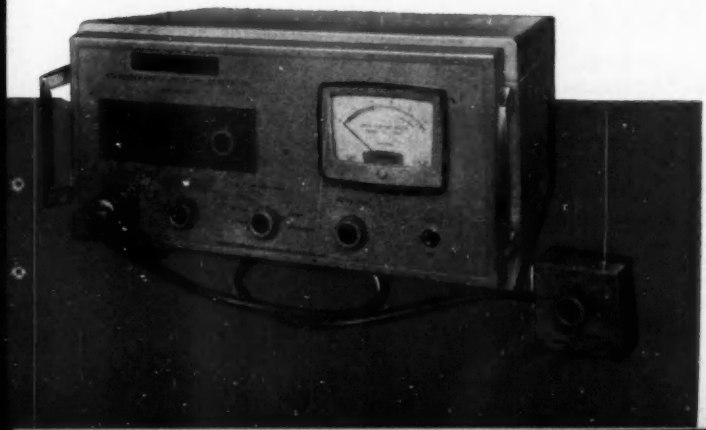
25 c/s—500 Kc/s, accurate to ±1.5%. Frequency stability: approx. 0.1%. Distortion: approx. 0.2% between 50 c/s and 200 Kc/s, < 1% outside these limits. 0.5 V r.m.s. (75Ω) or 10 V r.m.s. (600Ω). 0—60 dB attenuator.

audio ultra-sonic R.F.

STABILISED AMPLITUDE SIGNAL GENERATOR—DO 905

With external attenuator.

350 Kc/s—50 Mc/s, accurate to ±2%. Additional 50 Kc/s useful for 0 dB reference check. 40 mV—10 V (pk-pk). Amplitude stability: < ±2% change in 50 Kc/s—30 Mc/s, < ±5% in 30 Mc/s—50 Mc/s. Distortion < 5%, mainly 2nd harmonic.



Write immediately for full details:—

SOLARTRON

SOLARTRON LABORATORY INSTRUMENTS LIMITED

Cox Lane, Chessington, Surrey.

Telephone: Lower Hook 2150

Cables: SOLARTRON CHESSINGTON

Telex: 23842 SOLARTRON T.DIT

A Member of the Firth Cleveland Group

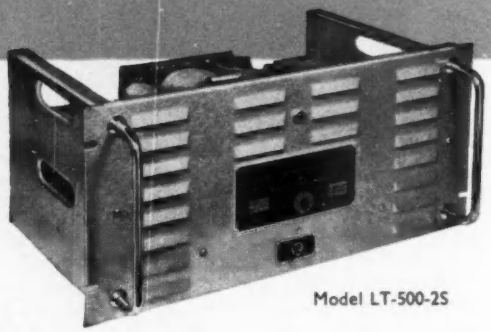
Model LT-150-2S

RATING 150 VA

Its compactness, fast response time of 0·1 sec., and adaptability make it an ideal chassis sub-unit. Particularly suitable for use with signal generators and similar low power equipment.

RATING 500 VA

Portable bench unit housed in a cabinet. Ample chassis space facilitates easy conversion to non-standard 115V. (nom.) output, thus making it suitable for use with American equipment. Response time 0·1 sec.

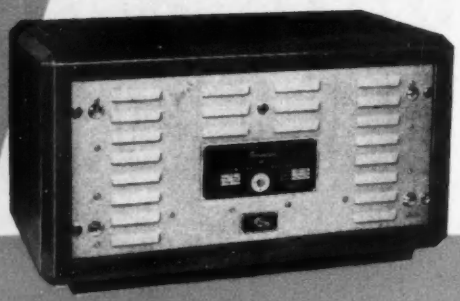


Model LT-500-2S

JLT ELECTRONIC

RATING 1000 VA

A fast response regulator suitable for laboratory or industrial use. In 19" rack mounting form it has been installed in equipment for export to areas where frequency, voltage, climate and load variations necessitate the best all-round type of regulator. Response time 0·1 sec.



Model LT-1000-2S

RATING 3000 VA

The ideal regulator for control applications, particularly in the case of photographic and similar processes, where stability is an essential factor for continuity.

Model LT-3000-2S

GENERAL SPECIFICATION (all models)

Input Voltage: ... ... 190V.—260V. A.C.
Output Voltage: ... 220V.—240V. A.C. (adjustable)
Output Regulation: ± 0·1% for changes in input voltage (r.m.s. values) ± 0·1% for changes in load current
Distortion: ... ... 3% under normal conditions
Power Factor Range: ... ... 0·9 leading to 0·7 lagging
Frequency: ... ... Pre-set for 50 c/s
Regulation satisfactory for ± 10% change in frequency
Distortion not greater than 5% for frequency changes of ± 2 c/s
Temperature compensated

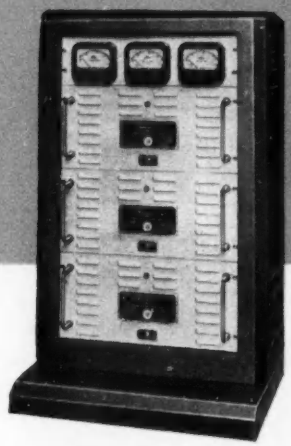
Tropicalised versions are available to special order.

EE 30 099 *for further details*

JLT instruments for industry

RATING 3000 VA

Three standard single-phase 1000 VA voltage regulators housed in a Datum instrument rack. May be used on either a single-phase or three-phase supply. This 'three in one' system is particularly suitable in metering and test laboratories and has been used successfully with Ferranti, Metropolitan Vickers, Elliott, Drysdale, and Chamberlain and Hookham meter testing benches.



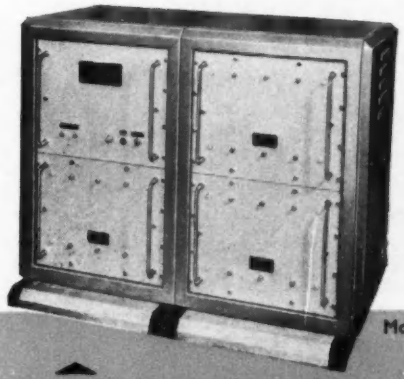
Model LT3P-1000-2S

RATING 5000 VA

The control and power units are each mounted on identical standard 19" front panels. This model is ideally suited for applications demanding exceptional voltage accuracy at load currents of up to 22 amps.
The response time of 0·3 sec. is negligible compared with motor control regulation systems.

Model LT-5000-2S

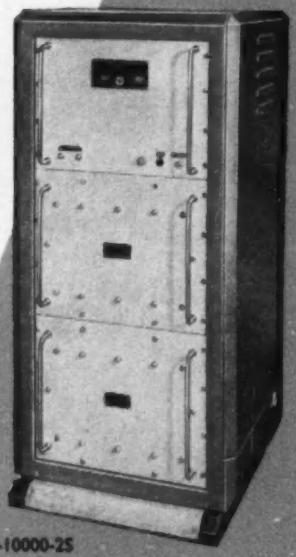
A.C. VOLTAGE REGULATORS



Model LT-15000-2S

RATING 10000 VA

This is the largest regulator to be housed in a single bay Datum rack, and is suitable for use with high-power oscillator and relay systems, lamp life-testing gear and crystal ageing equipment.
Response time 0·3 sec.



Model LT-10000-2S

RATING 15000 VA

This regulator consists of four units mounted in a two bay 3' Datum instrument rack. Over-voltage and overload protection are provided. A regulator offering exceptional accuracy at high currents.
Having a response time of 0·3 sec., it is particularly suitable for accurately controlling A.C. input to master transmitter/receiver circuits.

from the Power Supplies Division of

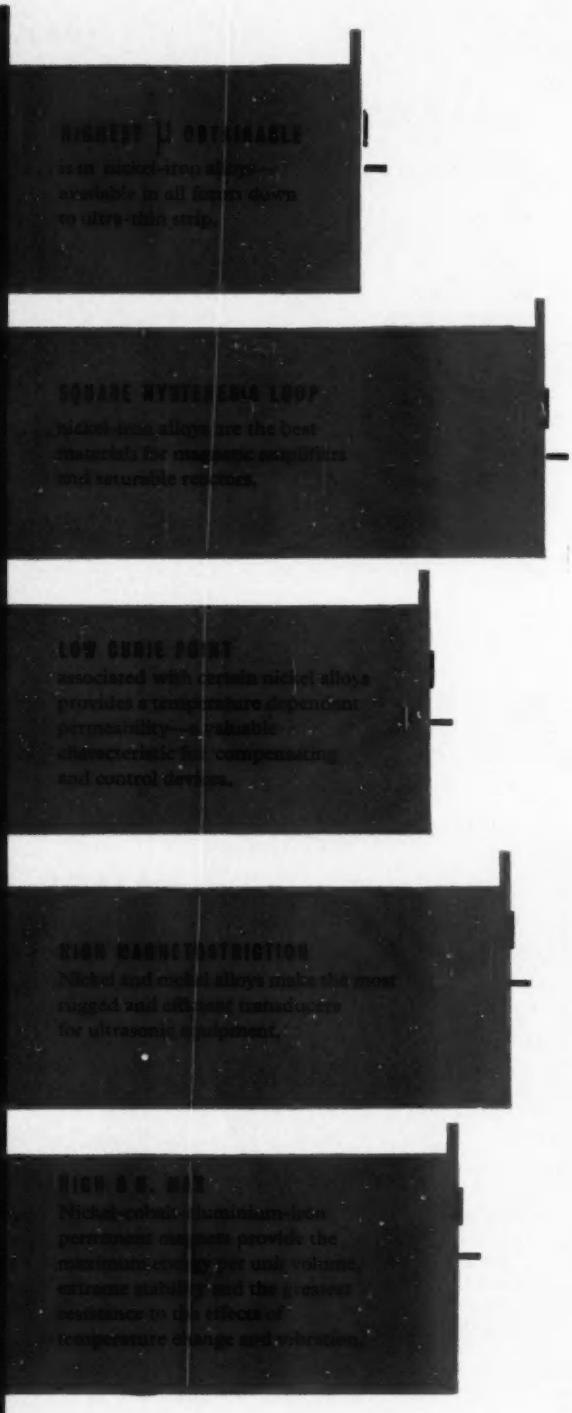
JLT GROUP

J. LANGHAM THOMPSON LTD

BUSHEY HEATH · HERTFORDSHIRE · ENGLAND
Telephone: BUShey Heath 2411 (6 lines) Grams & Cables: 'Tommy Watford'

VR 1

Before specifying magnetic materials consult this record

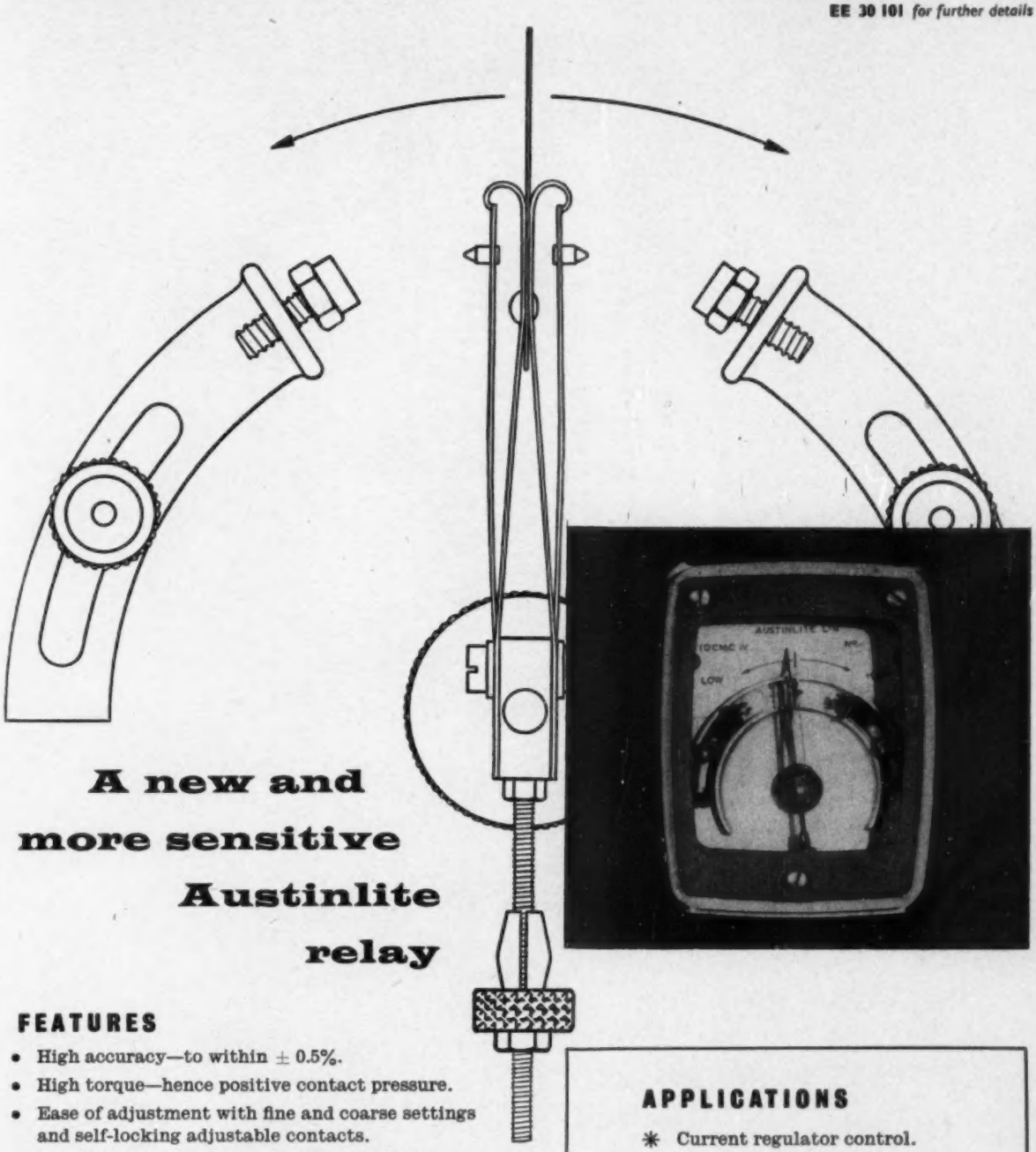


Design with Nickel-containing MAGNETIC MATERIALS

Send for a free publication 'Nickel-containing Magnetic Materials'

THE MOND NICKEL COMPANY LIMITED · Thames House · Millbank · London SW1

EE 30 101 *for further details*



A new and more sensitive Austinlite relay

FEATURES

- High accuracy—to within ± 0.5%.
- High torque—hence positive contact pressure.
- Ease of adjustment with fine and coarse settings and self-locking adjustable contacts.
- Choice of either two or four adjustable contacts.
- Contemporary case design—projection or flush mounting.
- Dustproof and suitable for use in the tropics.
- Conforms to Post Office Specification P.T. 1025B.
- Suitable for current or voltage sensing on either D.C. or A.C.

APPLICATIONS

- ✳ Current regulator control.
- ✳ Voltage regulator control.
- ✳ Monitoring duties.
- ✳ Limiting duties.
- ✳ Equipment protection.

Austinlite **ELECTRICAL EQUIPMENT**

Custom-built by STONE-CHANCE LTD.

(Makers of Sumo Pumps and Stone-Chance Lighthouses).
CRAWLEY, SUSSEX.

We can get you out of an Audio-Valve problem.

Here is a brilliant newcomer to the celebrated KT series of beam tetrodes—the KT 77. We have been getting people out of valve problems for over 40 years and now we've put all that experience into this valve, which joins our KT 55, 66 and 88 range.

	P_{out}† (W)	Distortion† (%)	V_{supply} (V)	DIMENSIONS Seated height (mm)	DIMENSIONS Max diameter (mm)
KT 55	25	1.5	*	128	53
KT 66	50	3	525	120	53
KT 77	70	1	600	98	33
KT 88	100	1.5	500	110	53

† Class AB_1, ultra-linear connection
* 190—260 V, AC or DC mains

A comprehensive range of audio valves is available, to give outputs up to at least 50 kW.

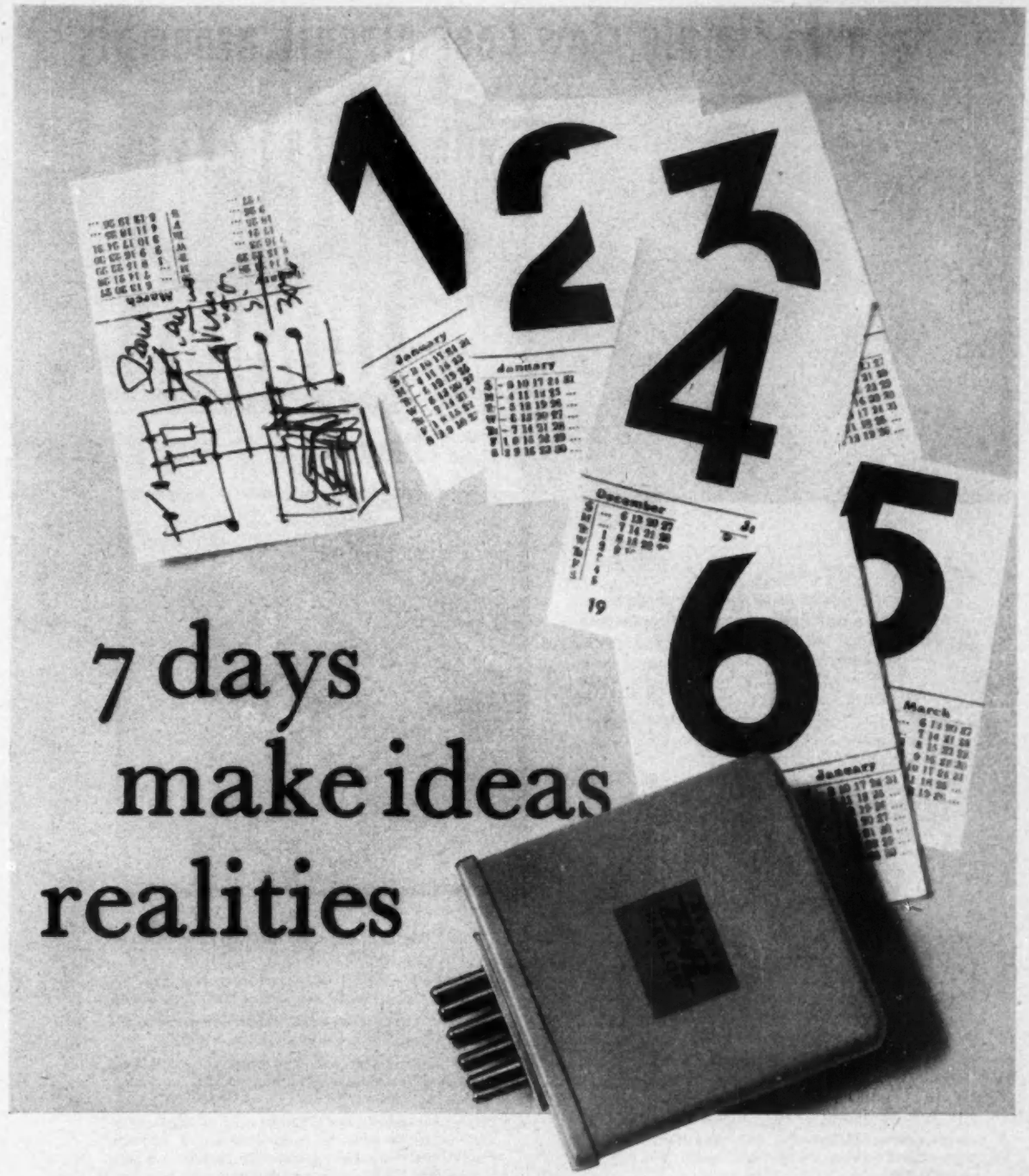
G.E.C.

For full details, write to:—

THE M-O VALVE CO LTD

BROOK GREEN · HAMMERSMITH · LONDON W6

A subsidiary of The General Electric Co Ltd



Knowing how important speed is to the designer this Company provides a special service in which speed is the keynote. There is a B. & R. department equipped to produce one off or small quantities for customers' prototype equipment. Please let us have details of your requirement.

Why not write and ask about it: or telephone Harlow 25231.

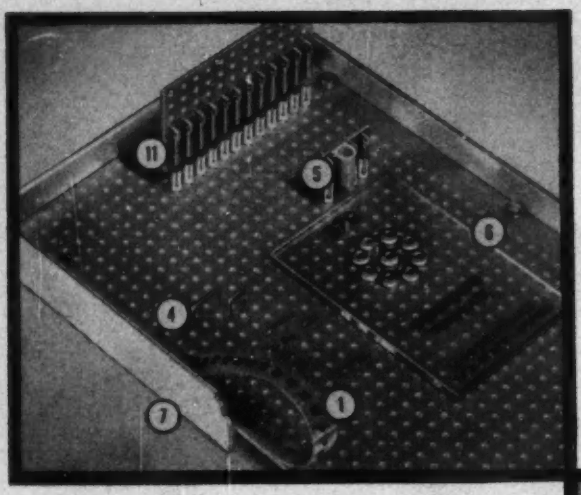
B & R RELAYS LIMITED

B. & R. RELAYS · TEMPLE FIELDS · HARLOW · ESSEX

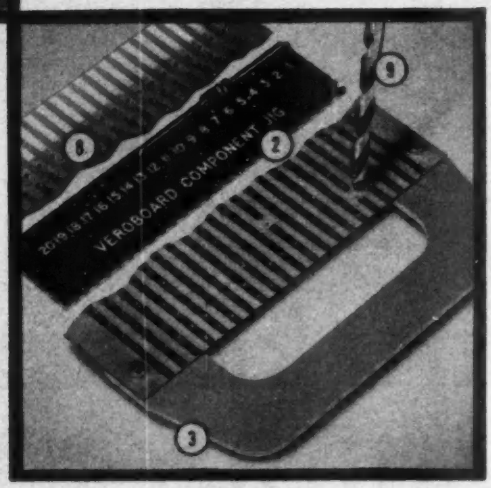
Telephone: Harlow 25231/4 *Member of the Gas Purification Group*

EE 30 104 *for further details*

Fast, simple, low-cost circuit assembly



with **vero board accessories**



VEROBOARD is the universal wiring board that combines all merits of the printed circuit technique—*without the expense!* Simplicity, speed, cheapness, and reliability are the direct results of the VEROBOARD principle: standard pitching of standard-size holes on a resin-bonded laminate board backed by bonded copper continuity strips.

The following assembly aids and accessories are offered to speed and simplify the assembly of VEROBOARD circuits even further; and to provide even better service in use.

1 **Numeral tape** (self-adhesive) for fast, accurate reference to positions on VEROBOARD. 1–90 for 18″ boards and 1–30 for boards up to 6″. Part Nos. VB3021 and VB3022

2 **Component Jig** for bending wire terminations accurately to fit VEROBOARD matrix. Part No. VB3031

3 **Plastic Handles** for plug-in VEROBOARD card circuits. Part Nos. VB3051 (black) and VB3052 (red)

4 **Jumper Links** of tinned copper wire for cross connections between bonded copper backing strips on VEROBOARD. Part Nos. VB3061 (0·2″) and VB3062 (0·4″)

5 **Semiconductor Holders** for mounting transistors, etc. with plug-in contacts on 0·2″ matrix. Part No. VB2011 and VB2012

6 **Valveholder Templates** for drilling holes at correct pitch and location on VEROBOARD. Part Nos. VB3041, VB3042 and VB3043

7 **Extruded Edging** in light alloy for strengthening VEROBOARD panels. Part No. VB3091

8 **Plug-in Panels**: 4·8″ × 5·8″ VEROBOARD, gold-plated at one end for use with edge connectors. Part No. VB2001

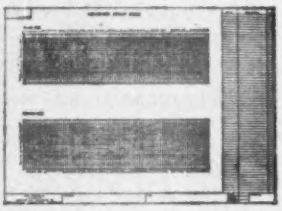
9 **Spotface Cutter** to make a clean separation where necessary in copper backing strip. Part No. VB3011

10 **Design Sheets** on high quality tracing paper for designing circuits on VEROBOARD and for producing workshop prints. Part Nos. VB3071 (18″) and VB3072 (6″)

11 **Varicon Connectors** which can be used as single point contacts or in rows to form connections between VEROBOARDS. Available in strips of 20. Part No. VB3081 (in line and VB3082 (right angle).

Notching Tool for Extruded Edging to enable it to be mitred for making corners and for slotting to take VEROBOARD panels. Part Nos. VB3101 Press, VB3102 Mitre die set, VB3103 Slotting die set.

VEROBOARD Kit contains supply of VEROBOARD and all accessories in a special container.



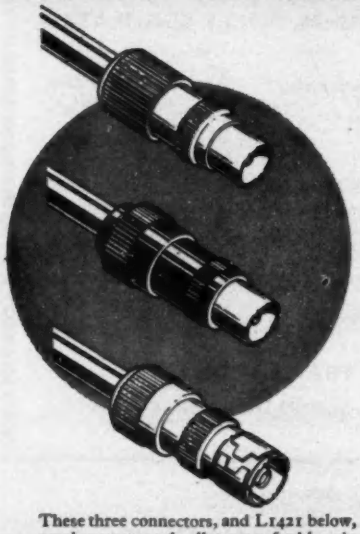
vero board

is a product of VERO Precision Engineering Ltd., South Mill Road, Southampton. Telephone: 71061/4

"Belling-Lee"

COAXIAL PLUGS AND SOCKETS*

These are the connectors on which the RECMF standards and subsequently BS plugs and sockets were based



These three connectors, and L1421 below, employ a patented collet type of cable grip which eliminates all strain on the internal connections.

L734/P/A1, L781/P2. These Free Plugs are of similar design, but whereas L734/P/A1 has a polished aluminium body, L781/P2 is insulated by a tough nylon sheath, with a cap of the same material, which is virtually unbreakable and available in a range of colours.

L734/J/A1 Free Socket. A useful accessory for extending cable runs in laboratories, workshops, etc. The body is polished aluminium, and a powerful steel circlip ensures adequate resilience at the mouth.

(On right)

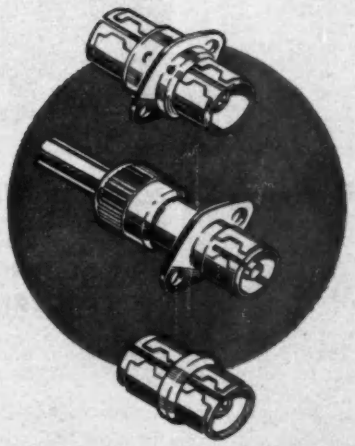
L617 Bulkhead Adaptor. For coupling two standard co-axial plugs through a panel, permitting the easy connection and dis-connection of leads on each side. Steel circlips are fitted.

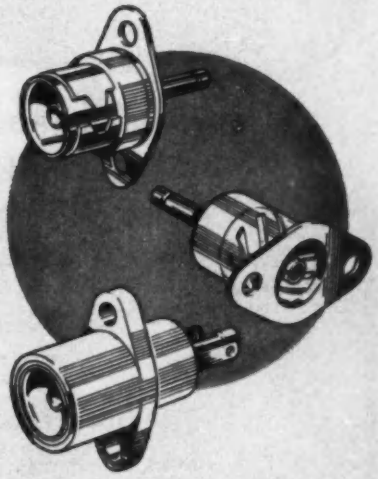
L1421 Bulkhead Socket. A chassis mounting socket with provision for maintaining the continuity of screening inside the equipment. This is a fixed version of L734/J/A1 above.

L616 Cable Adaptor. A handy accessory for joining random lengths of co-axial cable terminating in standard co-axial plugs. Fitted with steel circlips.

"Belling-Lee" coaxial connectors were designed to provide the most efficient general purpose terminations possible for solid dielectric, or semi-air-spaced cables between ¼" and ½" outside diameter. The dielectric used throughout is polythene, except in L 603, while centre contacts are silver-plated with tin-dipped solder spills.

So successful has the design proved that several members of the range have been granted quality approval for use by H.M. Services yet, due to the large quantities made and efficient production methods, the cost has been kept down to an exceptionally low level, which makes them competitive with ordinary co-axial plugs and sockets.





L604/S/Cd Fixed Socket. A general purpose chassis mounting socket, with steel circlip providing constant, controlled resilience of the mouth.

L734/S Fixed Socket. This is an alternative socket for flush mounting. Resilience of the body is enhanced by the diagonal slots, which are shrouded in a polythene sleeve to exclude dirt.

L603 Insulated Fixed Socket. The body is made of nylon (/A) or high impact polystyrene (/B) with an internal metal liner and circlip for the outer connection. The nylon version is supplied in 5 standard colours, black, blue, green, red and yellow.

Most "Belling-Lee" products are covered by patents or registered designs or applications.

Regd.

TERMINALS · PLUGS & SOCKETS* · GLASS SEALS
CIRCUIT PROTECTION DEVICES
INTERFERENCE FILTERS · RECEIVING AERIALS

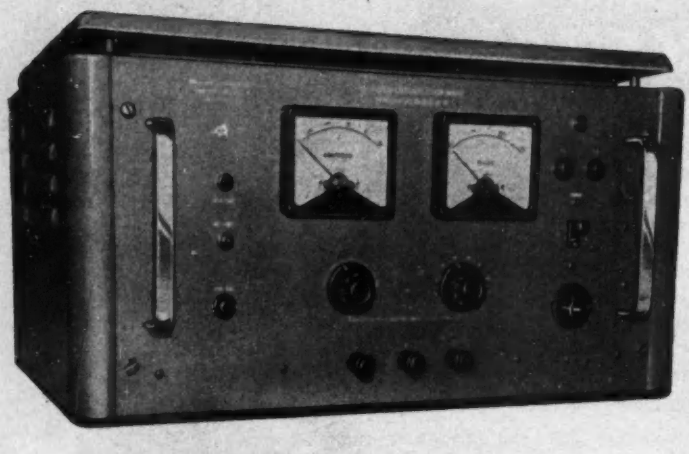
BELLING & LEE LTD
GREAT CAMBRIDGE ROAD, ENFIELD, MIDDX., ENGLAND

Telephone: Enfield 5393 · Telegrams: Radiobel, Enfield

EE 30 106 *for further details*

PRECISION WORKMANSHIP

is the Keynote . . .



0 TO 30 VOLTS D.C.

AT 10 AMPS. FULLY REGULATED

Output resistance:	0.01 ohm.
Stabilisation:	1000 : 1
Ripple:	1mV. peak to peak
Mains Supply:	200/250 v. 50 c/s

OVERLOAD CUT-OUT.

FULLY FLOATING OUTPUT TERMINALS.

SILICON AND GERMANIUM DEVICES USED THROUGHOUT.

TRANSISTOR POWER SUPPLY
TYPE KTV/310

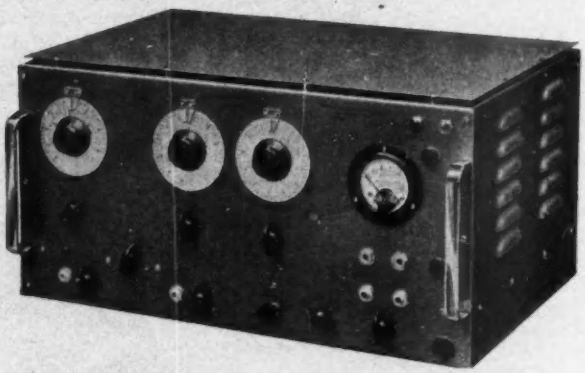
OTHER TRANSISTOR
POWER SUPPLIES AVAILABLE

PULSE GENERATOR

TYPE 302A

GENERAL PURPOSE

LABORATORY INSTRUMENT



½ amp. peak current available in output 0 to 100 volts continuously variable output. Fully Regulated Internal D.C. supplies. Rise Times of 0.015 μS. Low output impedance. Extremely small jitter.

SPECIFICATION:

Oscillator frequency:	10 c/s to 10 Mc/s.
Delay:	0.3μs. to 10 ms.
Pulse Width:	0.1μs. to 10 ms.
Pulse amplitude: (positive or negative)	0 to 30 volts into 75 ohms. 0 to 100 volts into 1,000 ohms.
Square waves:	10 c/s to 1 Mc/s.

The instrument can be synchronized or triggered from an external source.

Also available

DOUBLE PULSE GENERATOR
TRANSISTOR ANALYSER
STABILIZED POWER SUPPLIES

both high voltage and low voltage giving output currents of 50 mA. to 10 amps.

For full information and descriptive literature on other LABORATORY TESTING EQUIPMENT
call, write or phone

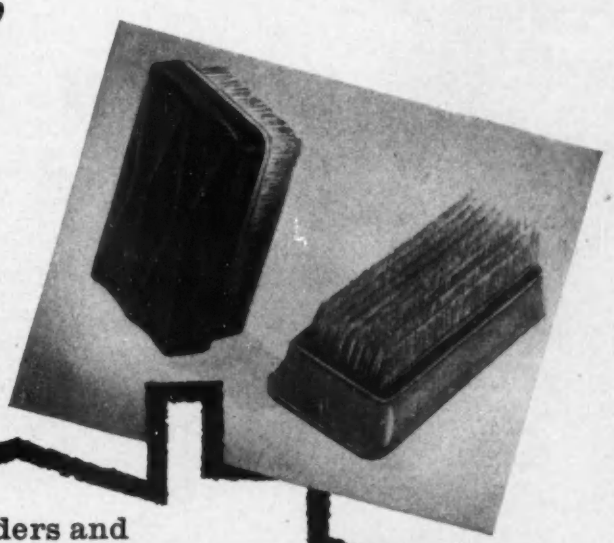
KASAMA ELECTRONICS LTD

139-149 FONTHILL ROAD, FINSBURY PARK, LONDON, N.4

Telephone: ARChway 6160

EE 30 107 *for further details*

Denman Products Ltd. won the 1960 'Alkathene' design trophy



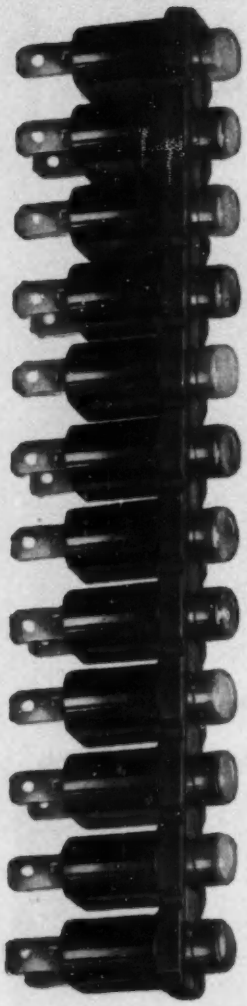
Take your injection moulding to Denman Products Ltd., and you call in not only a moulder but a mould maker, Denman Tools Ltd. That means you get the whole job, from pencil sketch to successful product, all done under one roof. These brushes, made from 'Alkathene' I.C.I. polythene, won the 1960 'Alkathene' Design Trophy and show just what good design and production can mean. Write to or telephone Denman Products Ltd. now.

Moulders and mould makers under one roof

A12 *'Alkathene' is the registered trade mark for the polythene manufactured by I.C.I.*

DENMAN PRODUCTS LTD., Bridgefields, Tewin Rd., Welwyn Garden City, Herts. Tel: Welwyn Garden City 6338

EE 30 108 *for further details*



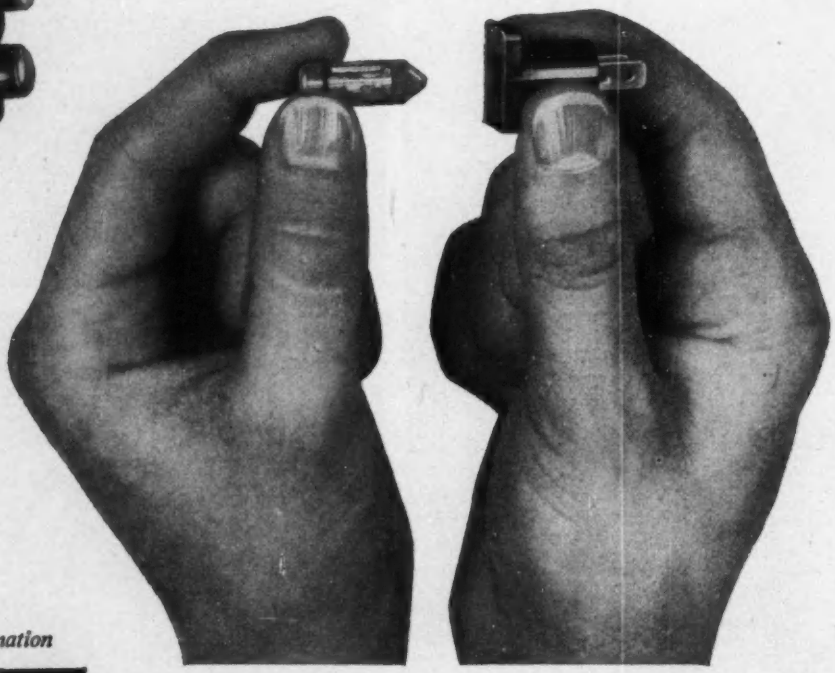
MULTI-SOCKET INDICATOR STRIP

Simplifies indicator problems for the designer and the installation engineer.

The new Thorn multi-socket indicators are ideal for use with computors and illuminated read-out devices. They are produced in strips of twelve sockets with $\frac{1}{2}$ or $\frac{3}{4}$ in. centres. Only one earth connection is required irrespective of the unit length employed.

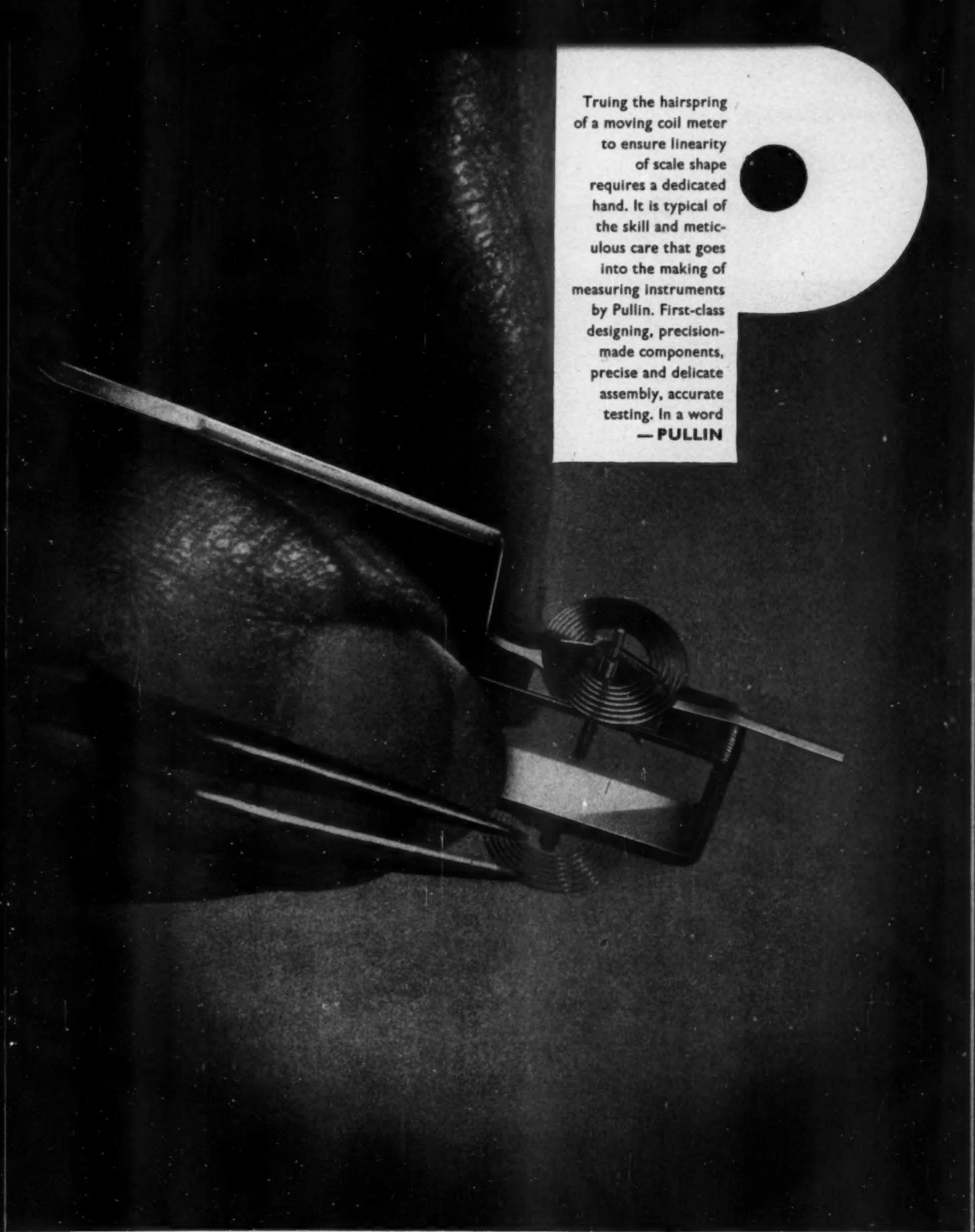
An Easy-mount single socket similar to the indicator strip is also available, and can be used separately or in conjunction with multi strip-socket.

Lamps are available in 6, 12, or 28 volts, 35—45 mA, with a burning life of 3,000—5,000 hours. Plastic nylon caps are obtainable in White, Red, Yellow or Green, these fit directly over the lamp and eliminate the need for prismatic jewels.



For further information write to:

THORN ELECTRICAL INDUSTRIES LIMITED
Special Products Division (incorporating Components and Connectors),
Great Cambridge Road, Enfield, Middlesex. ENFIELD 5353.



Truing the hairspring of a moving coil meter to ensure linearity of scale shape requires a dedicated hand. It is typical of the skill and meticulous care that goes into the making of measuring instruments by Pullin. First-class designing, precision-made components, precise and delicate assembly, accurate testing. In a word —**PULLIN**

Pullin for precision

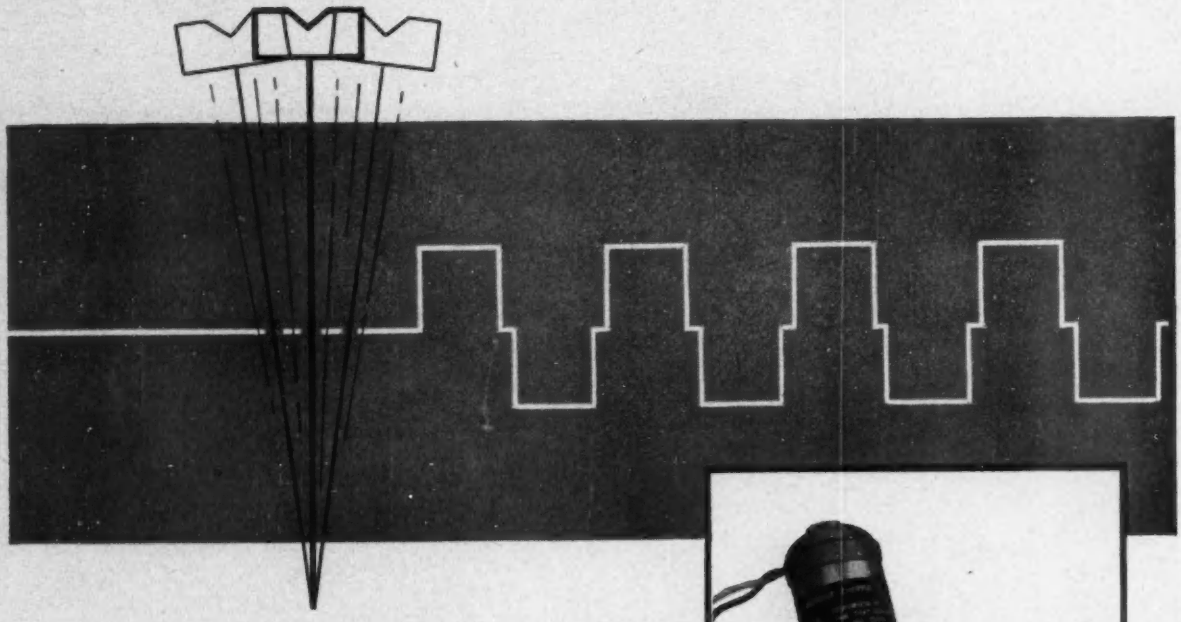
M·I·P

MEASURING INSTRUMENTS (PULLIN) LTD.

ELECTRIN WORKS, WINCHESTER STREET, LONDON W3. ACOrn 4651 & 8801

London Showrooms: Electrin House, 93-97 New Cavendish Street, London W1. LANgham 4551-6

EE 30 110 *for further details*



THE 'SYNCHRONOUS CHOPPER' TYPE CK3

SOME FEATURES

- ★ Low Electrical Noise (designed for high-impedance measurements)
- ★ Contact Settings Readily Adjustable
- ★ Small Size (Fits standard B9A valve base)
- ★ Hermetically Sealed

AEI

Associated Electrical Industries Ltd.

Instrumentation Division - Instrument & Meter Department

TRAFFORD PARK, MANCHESTER, 17

G/R 801

For Quality Instrumentation

MATSUSHITA ELECTRIC

employ

MARCONI TEST EQUIPMENT

Some of the Marconi test equipment installed in the Radio & Parts Factory of Matsushita Electric, manufacturers of FM broadcasting installations, sound systems, television receivers, radios and many other products in the electronics field.

STANDARD SIGNAL GENERATOR TF 867

A precision laboratory instrument covering the frequency range 15 kc/s to 30 Mc/s. Features include a high quality r.f. output, a built-in crystal calibrator, automatic level control, and sinewave a.m. monitored and variable to 100%. For full details write for Leaflet J 189.

The Electronics Division of Matsushita Electric, one of Japan's largest industrial organisations (28,000 employees) and holders of Japan's highest award for scientific quality control work, makes extensive use of Marconi test equipment. Quality instrumentation is the prerequisite for quality production, and Marconi Instruments are proud that standard items from their range of test equipment serve the electronic industry, not only in Japan, but throughout the world.

MARCONI INSTRUMENTS

THE INTERNATIONAL CHOICE FOR ELECTRONIC MEASUREMENT

AM & FM SIGNAL GENERATORS · AUDIO & VIDEO OSCILLATORS · FREQUENCY METERS · VOLTMETERS · POWER METERS · DISTORTION METERS TRANSMISSION MONITORS · DEVIATION METERS · OSCILLOSCOPES, SPECTRUM & RESPONSE ANALYSERS · Q METERS & BRIDGES

London and the South: English Electric House, Strand, W.C.2 Telephone: COVent Garden 1234

Midlands: Marconi House, 24 The Parade, Leamington Spa Telephone: 1408

North: 23/25 Station Square, Harrogate Telephone: 67455

Export Department: Marconi Instruments, Ltd., St. Albans, Herts, England. Telephone: St. Albans 59292

REPRESENTATION IN 68 COUNTRIES

TC 189

EE 30 112 *for further details*

DERRITRON Electronics GROUP

BEME TELECOMMUNICATIONS LTD · CHAPMAN ULTRASONICS LTD

DORAN INSTRUMENT CO. LTD L.S.B. COMPONENTS LTD RESLOSOUND LTD

NOW CLOSED CIRCUIT T.V. IS WITHIN THE REACH OF ALL

at ⅓ normal cost

Until recently Closed Circuit T.V. was not an economic proposition for many firms and laboratories because of the high capital outlay, now BEULAH have changed this with the introduction of the BEULAH D.800 Closed Circuit Camera. The D.800 is extremely light and compact (size 12″×7″×6″, weight 14 lb. approx.) and can be used in conjunction with standard T.V. receivers. Excellent results are obtained with ordinary room lighting, and as many as 20 receivers can be fed by the D.800 camera up to distances of 4,000 ft.

Ultra-violet and infra-red sensitive tubes are available.

Closed circuit T.V. has a thousand uses in science and industry of which the following are only a few—Research observation, demonstrations, instruction, process control and instrument monitoring—You will find that the BEULAH D.800 camera has a particular application to your own special problem.

BEULAH ELECTRONICS

● *Demonstrations of the D.800 are gladly arranged. Please write for further details and full specification to :*

BEULAH ELECTRONICS LTD

LSB COMPONENTS LTD are experts in COIL WINDING AND ENCAPSULATION and

manufacturers of highly specialized electronic components to specification. Your enquiry will be dealt with promptly.

LSB COMPONENTS LTD

sales enquiries for all companies · 24 UPPER BROOK ST · MAYFAIR · LONDON · W1 · PHONE HYDE PARK 2291

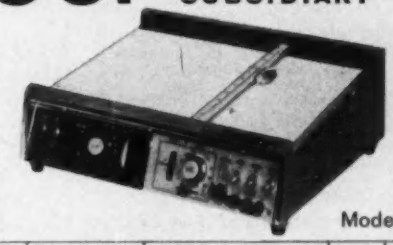
Da261 EE

F.L.MOSELEY CO.

HEWLETT-PACKARD SUBSIDIARY

AUTOGRAF X-Y RECORDERS

Any test data which can be reduced to electrical form can be plotted on the Autograf.



Model 2D

	Model	Paper size	Pen speed (full scale deflection)	Input Voltage Ranges DC	Input Voltage Ranges AC	Time base intervals	Other characteristics		Price
X-Y-Recorder «Autograf»	1	8½"×11"	1 sec	5 mV – 100 V	with A1 converter		Paper on drum		£ 441
	2 D	11"×17"	20"/sec	7.5 mV – 150 V X-Axis	1.5 V – 150 V	7.5 – 750 sec	Vacuum hold-down Roll chart optional	Accuracy 0.2 % of full scale	£ 974
	2 S		1 sec	5 mV – 100 V Y-Axis					£ 820
	3 S	8½"×11"	0.5 sec	5 mV – 500 V		5 – 500 sec			£ 575
	4 B	11"×17"	1 sec	7.5 mV – 150 V X-Axis	with A1 converter	7.5 – 750 sec	Rack mount		£ 1430
	4 S			5 mV – 100 V Y-Axis			Rack mount		£ 820
	5 S	8½"×11"	0.5 sec	5 mV – 500 V		5 – 500 sec	Rack mount		£ 646
	6 S	10"×10"	< 1 sec	5 mV – 100 V			Rack mount Paper on rolls		£ 1030

	Model	Paper width	Pen speed (full scale deflection)	Input Voltage Range DC	Input resistance	Chart speeds	Accuracy		Price
Strip Chart Recorder	60 A	10" ROLL	.25 sec	5 mV – 100 V	200 000 Ω/V max. 2 MΩ	6 speeds 2" – 60"/min	0,2 %		£ 732

	Model	Dynamic Range	Stability	Accuracy	Response speed	Input Voltage Ranges DC	Input Voltage Ranges AC		Price
Logarithmic Converter	60 B	60 db	± 0.5 db	± 0.5 db	20 db/sec	3.16 mV – 316 V	1 mV – 100 V 20 cps – 20 KC		£ 291

Accessories available:

Model 30A Card Translator
Model 40A Keyboard
Type F1 Curve Follower Adaptor
Type A-1 AC to DC Converter
Type D-1 Character Printer

The Autograf X-Y Recorder is a complete self-contained instrument which will record directly in Cartesian coordinate form many mechanical and physical, as well as electrical phenomena.
As a curve follower, it will control many industrial and manufacturing processes. Used in laboratories and industrial plants throughout the world.

Prices delivered U.K. exclusive of duty where payable. Continuous progress in design may affect the above specifications which are therefore subject to change without notice. For information, technical sales and engineering help, or a demonstration please write or call

Hewlett-Packard S.A.

Geneva (Switzerland) Rue du Vieux-Billard 1, Tel. (022) 26 43 36

Exclusive Distributor for United Kingdom:

LIVINGSTON LABORATORIES LTD.
RETCAR STREET, LONDON, N. 19

Telephone: ARChway 6251

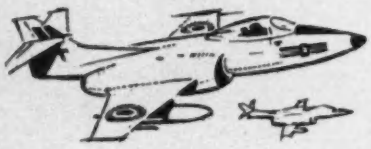
HPSA - 8 - 412

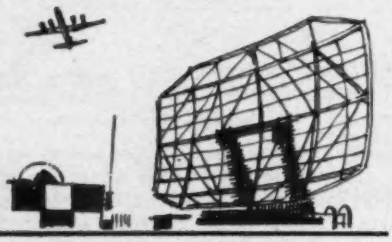
leads the way

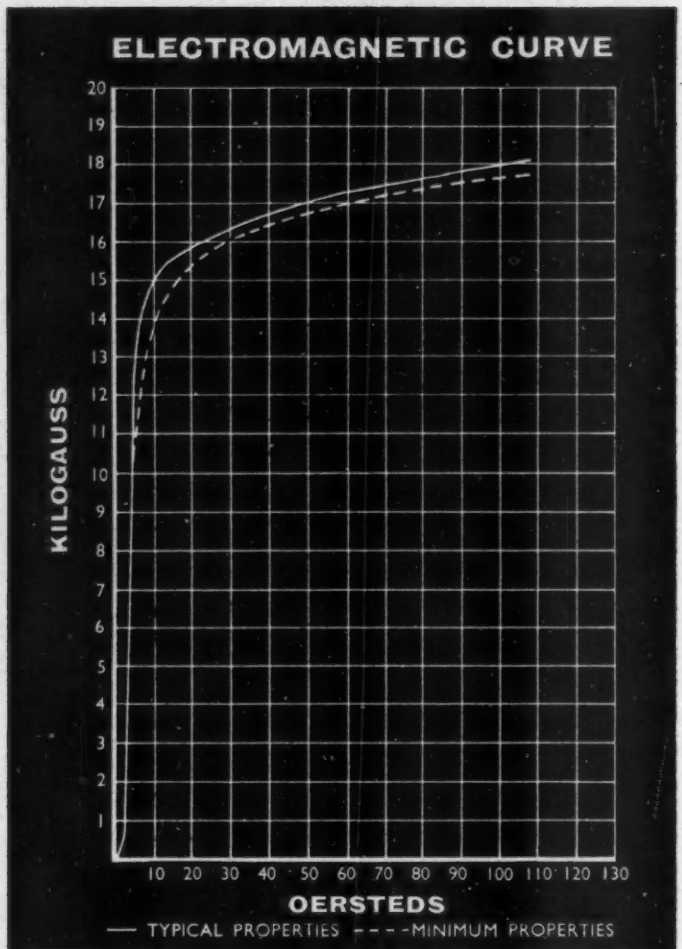
The excellent electromagnetic properties of

Purefee AND REFINED MAGNETIC IRONS

These special irons are suitable for a wide range of applications in electrical and electronic equipment. After rough machining, followed by annealing treatment, toroidal ring testing results exceeding the minima shown on the table, can be expected.





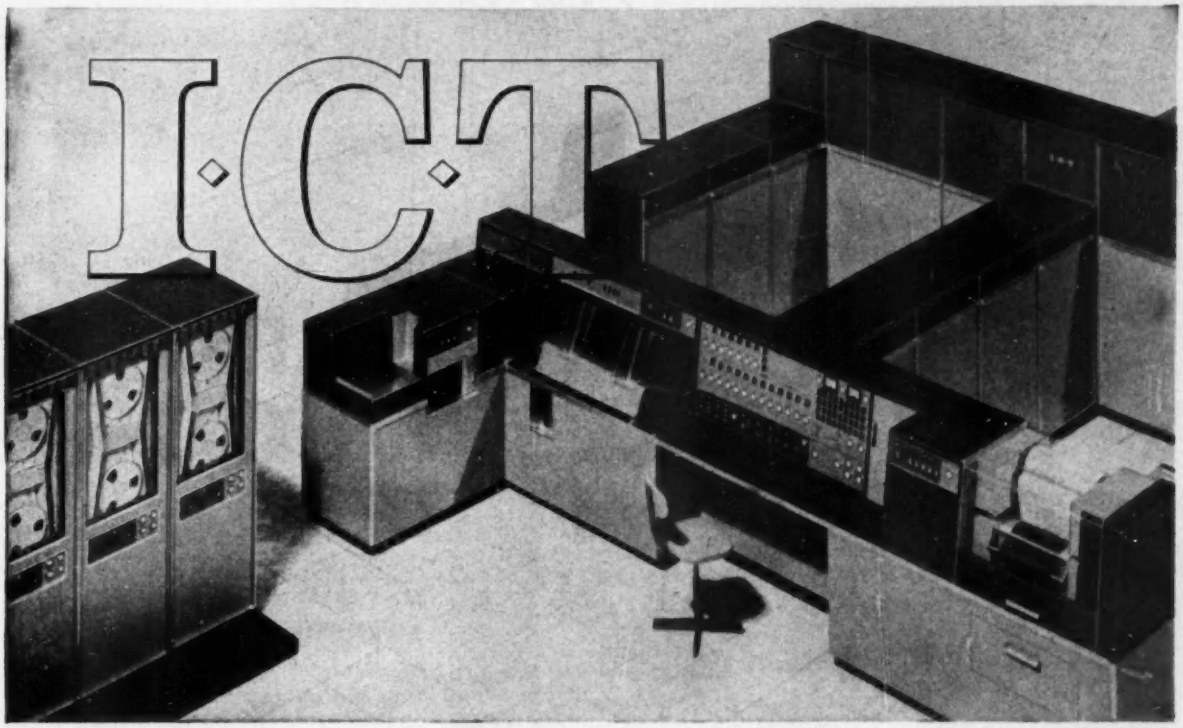


FIELD STRENGTH (H)		FLUX DENSITY (B)
Ampere Turns/cm	*Oersteds*	*Gauss(minimum)*
3·5	4·40	11,400
6·0	7·54	13,400
10·0	12·57	14,600
20·0	25·13	15,800
50·0	62·83	17,000
80·0	100·53	17,600
REMANENCE		9.000 (*minimum*)

MIDLAND AND LOWMOOR IRON & STEEL CO. LTD.

Rotherham. Telephone: Rotherham 4211/2/3

MI 16



No words, no specification, can capture the real quality of a computer

A computer is the sum of the thinking, the engineering, the experience that go into its making, *plus* the accumulated skills that go into its applications and servicing.

On all these scores, I·C·T has no equal in Britain. I·C·T, with over 50 years' experience of data processing, has made more than half the computers in commercial use here today. I·C·T in Britain is deployed over 23 factories, 31 area offices, 3 research establishments, and 5 educational and training centres for customers' staff. World-wide, I·C·T employs 19,000 people and operates in 51 countries. I·C·T's service is at *your* service from the moment of your first enquiry.

The computer illustrated is the 1301. It is a product of I·C·T and G.E.C. and their jointly owned Computer Developments Limited. A comprehensive booklet on the 1301 can be had on request.

ICT

International Computers and Tabulators Limited

149 PARK LANE, LONDON W1. TELEPHONE: HYDE PARK 8080

USE MULLARD TRIGGER TUBES

in control and switching circuits for . . .

Life and Reliability
Mullard cold cathode tubes offer a life expectancy and reliability comparable with the highest quality components used in electronic equipment.

High Sensitivity
Only a small energy pulse is required to "trigger" the main discharge. A gain of 100,000 may be achieved.

Instantaneous Operation
Cold cathode tubes are always ready for instantaneous operation. They are ideal for stand-by and intermittent duty applications.

The Mullard range at a glance

Z700U Low cost subminiature tube for use in computing/switching circuits.

Z700W Subminiature tube with two trigger electrodes for use in reversible ring counters.

Z701U Subminiature tube particularly suited for speech passing in electronic telephone exchanges.

Z803U Extremely stable, close tolerance miniature tube.

Z900T Miniature tube intended primarily for intermittent operation from d.c. or 115 volt a.c. supplies.

Full information on the range of Mullard trigger tubes is available —please write or telephone Mullard House

MULLARD LIMITED
Mullard House · Torrington Place
London W.C.1 · Tel: LANgham 6633

Mullard
GOVERNMENT AND INDUSTRIAL VALVE DIVISION

MVT4028

ELECTRONIC ENGINEERING

VOL. 33 No. 396

FEBRUARY 1961

Commentary

TELEVISION, in this country has been in a somewhat unsettled state for some time and the three main questions which have been bubbling and rumbling for the last few years have recently come very much to the fore. The matters in question are: Should further (monochrome) programmes be introduced? Should a change be made in line standard? Should a colour service be introduced?

The first question is a sheerly social and economic matter and, as such, lies outside our range of comment except in so far as it is affected by the answers to the other questions.

The second and third questions may be split in two: there are the technical arguments and the social and economic factors. But, ultimately, and before a complete answer can be given to either question, the two halves must be brought together and be made to fit, and it is at this point that the trouble really arises.

Both the Radio Industry Council and the Postmaster General's Television Advisory Committee are in agreement that 'colour should only be introduced using the line standards ultimately to be adopted for monochrome transmission and therefore any decision with regard to the introduction of colour must follow a decision on line standards', and, on the face of things this seems to be a logical proposition.

The technical arguments in favour of an increase in line standard have already been well aired and the only standard now seriously considered, apart from our own 405 line system is one of 625 lines. This is already in use by some 31 other countries including most of Europe except France and Belgium. It may of course be argued that an even higher line standard would be beneficial but this must, naturally, be considered in conjunction with the bandwidth available and in this context 625 lines is the highest that can be usefully employed. Given a completely perfect system there is no doubt that 625 lines provides a considerably better picture than 405 lines, but few broadcasting systems make a very close approach to perfection. To make full use of a 625 line system a total channel width of some 8Mc/s is required and while this would probably present no great problem on the u.h.f. Bands IV and V a channel width of more than 7Mc/s could not be used on Bands I and III without curtailing their exploitation. Here it must be remembered that the u.h.f. bands are completely untried and it is by no means certain that the viewer could be provided with the same satisfactory service on these bands that he now receives on the v.h.f. bands. At the receiving end it is probably true to say that in a typical home the television receiver is seldom adjusted correctly which makes the provision of a higher transmitting standard a little pointless to say the least; but against this is the fact that larger cathode-ray tubes are coming into widespread use and since they are invariably viewed from too short a distance an increase in line standards is more than ever necessary.

With regard to compatability with other countries, and particularly Europe, it should be borne in mind that the line standard is not the only parameter; there are others such as polarity of modulation and type of audio modulation.

The question of whether or not we should change our line standard was considered from a technical aspect by the Television Advisory Committee and in their Report issued last May they concluded that if more than three programmes are to be provided then it is imperative to use Bands IV and V and they recommend that if these bands are used a 625 line system should be employed and that this should ultimately be extended to Bands I and III.

Subsequent to the T.A.C. Report, the Television Reception Policy Committee of the Radio Industry Council have studied the matter on a much broader basis, which has included the economic and social consequences of a change over to 625 lines, and they have come down very heavily against any change. The Radio Industry Council state that about 80 per cent of television receivers are produced by their members and thus this Memorandum may be taken to fairly represent the greater part of the industry. Further, since the Chairman of the Television Policy Committee of the R.I.C. is a signatory to both the T.A.C. Report and the Memorandum it may be concluded that the R.I.C. have found the social and economic factors to weigh more heavily than sheerly technical merits.

The main reason the R.I.C. give for their attitude is that, in their estimation, if a change was made to a 625 line standard a period of fifteen to twenty years would be required to give national coverage to more than three programmes, during which time the public would suffer confusion and additional cost. This estimate of time is based on the fact that the change would have to be made in stages and that at no time could existing sets be made obsolete.

It is apparent that if the R.I.C. appraisal of the situation is realistic then any improvement in picture quality brought about by a change in standards would have to be considerably more than marginal to offset the inconvenience and expenditure involved.

It is equally apparent that undue delay in arriving at and announcing a sound, long term decision will be both unsettling and damaging to the Television Industry.

ELECTROLUMINESCENCE
its Characteristics and Applications

By D. H. Smith*, M.Sc., Ph.D., A.M.I.E.E.

(Part 1)

In Part 1 of this article the characteristics of the light emitted from electroluminescent cells energized by sine waves, square waves, and pulses of voltage are described, and the mechanism of electroluminescence is discussed briefly. In Part 2 some of the many applications are reviewed. For example electroluminescent cells can be used as light sources and for the visual display of information, light amplifiers can be made from a combination of electroluminescent and photoconductive elements, and it is conceivable that an array of very small electroluminescent cells could be used as a thin-screen television display.

(Voir page 128 pour le résumé en français; Zusammenfassung in deutscher Sprache auf Seite 135)

ELECTROLUMINESCENCE which is still to most people an unfamiliar phenomenon, is the sustained emission of light from a phosphor which is being energized by an alternating current. A phosphor is a substance which emits visible light (i.e. luminesces) when it is irradiated by ultra-violet or by α-rays, X-rays, or a beam of electrons. The basis of a phosphor is an insulating crystal which becomes luminescent when a small proportion of impurity atoms is added. The impurity atoms or 'activators' are able to absorb the incident radiation, becoming ionized (that is, losing an electron) in the process. At some later time the free electrons will recombine with ionized activators and light will be emitted. A phosphor will be electroluminescent if a mechanism exists whereby sufficient energy can be absorbed from an externally applied electric field to ionize the activators.

Electroluminescence was first observed by Destriau in Paris in 1936 but it was for many years regarded as no more than a laboratory curiosity. However, after a review of Destriau's work, written in English and published in 1947, interest increased enormously and several large industrial organizations began studies into the fundamentals of electroluminescence and its possible applications. Although this has resulted in greatly improved techniques in the making of phosphors, it has been found that very few phosphors can be made electroluminescent. By far the most useful is the zinc sulphide group with which Destriau's original experiments were made. The colour of the emitted light depends on the impurities used as activators, and it is possible to obtain blue, green, yellow or red. In contrast to the feeble glow which was all that could be obtained in the early days it is possible now to make experimental cells with a brightness approaching that of fluorescent tubes.

In the sections which follow some of the characteristic properties of electroluminescent cells are described. These properties were observed with cells made from a zinc sulphide phosphor activated with copper, and having chlorine as a co-activator (ZnS: Cu, Cl). This phosphor emits a bluish-green light, and its colour changes from being predominantly green at very low frequencies to predominantly blue at high frequencies. Observations have also been made on cells using a (ZnS: Cu, Al) phosphor which emits green light. These observations, as well as published papers in which experiments on other zinc sulphide phosphors have been reported, make it clear that the main features of electroluminescent emission are common to all ZnS phosphors, although differences in detail are to be expected.

* *Naval Research Laboratory, New Zealand.*

The Electroluminescent Cell

Fig. 1 is a diagrammatic cross-section of a cell and shows that it is essentially a capacitor having two flat

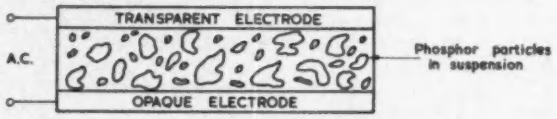


Fig. 1. Cross-section of electroluminescent cell

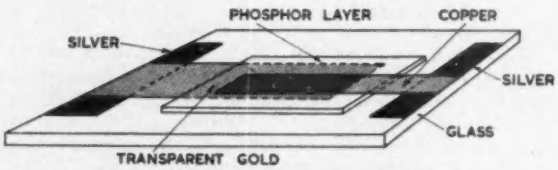


Fig. 2. Construction of electroluminescent cell

metallic electrodes, with a thin layer of phosphor between them. This layer consists of fine particles suspended in a clear insulating plastic or resin. One of the electrodes must be transparent so that the luminescence can be observed. Fig. 2 shows details of the construction of a typical experimental cell on a thin glass slide. The transparent electrode is made by depositing on the glass a thin film of bismuth oxide, and then a film of gold. The total thickness is about one millionth of an inch, and the resistance is very low, between 5 and 10Ω per square. Alternatively a piece of 'conducting glass' which has a thin coating of tin oxide, can be used. It is more robust and transmits light just as well, but its resistance is greater than 100Ω per square. The phosphor layer is applied in liquid form by spraying or spinning, and is then allowed to harden. The top or 'back' electrode can be of any stable metal with a low resistivity. It is often made by depositing a thick layer of copper (or aluminium or indium). Heavy silver contacts are provided so that soldered connexions can be made to the electrodes. They are baked into the glass before the cell is made, and the electrodes are formed so that each overlaps one of the contacts.

In order to obtain a useful intensity of emission an average electric field strength of the order of 1 to 5

$\times 10^4$V/cm is required, so the phosphor layer must be thin; it is often about ·005cm. The area of a cell may vary from a few square millimetres to many square centimetres, and the capacitance is about 100pF/cm^2.

Experimental work on electroluminescent cells is carried out with apparatus such as that shown in Fig. 3. Sine waves, square waves, or other waveforms, having a wide range of amplitude and frequency can be used to energize the cell, the resulting light emission being detected by a photo-multiplier. The voltage developed across a resistance in the anode of the photo-multiplier is amplified and applied to one pair of *Y* plates on a double-beam c.r.o. The exciting voltage can be applied to the other pair. Measurements can be made on the waveforms of the light pulses, as well as on the intensity of the emission (i.e. the brightness of the cell).

Sine-Wave Excitation

When a sine wave of frequency f is applied to an electroluminescent cell, it is found that light is emitted with a frequency $2f$. As shown in Fig. 4 there is a peak in the light waveform in each half-cycle of the applied voltage. Microscopic examination shows that the flashes of light from individual particles of phosphor come alternately from small areas on each side of the particle, emission occurring only at the side that is instantaneously positive. There is a noticeable asymmetry in the brightness waveform shown in Fig. 4, the peaks corresponding

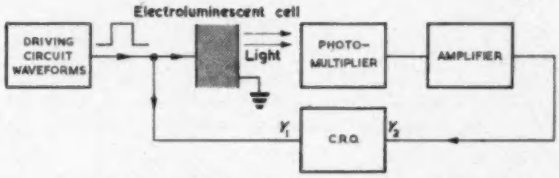


Fig. 3. Apparatus for examining electroluminescent waveforms

to the two halves of a voltage cycle being of different amplitudes. The peaks which occur when the transparent electrode is positive are always greater than the peaks which occur when it is negative. This is a result of the sources of emission being, on the average, farther from the surface, so that more absorption occurs. This so-called 'optical asymmetry' is found to a greater or lesser extent in all electroluminescent cells, the ratio of the amplitudes of successive peaks being from about 1·05 to 1·35.

When a sine wave of a given frequency is applied to the cell it is found that the average brightness B (or 'integrated light output'), increases very rapidly as the voltage amplitude, v, is increased. B obeys an equation of the form

$$B = a \exp(-b/\sqrt{v}) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

This is illustrated by plotting B on a logarithmic scale against $1/\sqrt{v}$, when a straight line with a slope of b is obtained (Fig. 5). a and b are parameters which depend on a number of factors, such as the frequency, temperature, type of phosphor, and construction of the cell. In a given case, when v is doubled the brightness may increase by a factor of 100 or more. Equation (1) has been found to hold over a range of eight decades of brightness, and can be applied when square waves, triangular waves and differentiated pulses are used. In addition the light emission from single crystals of zinc sulphide, and from individual spots in a cell, can be described by the same equation.

When the voltage amplitude is constant the brightness increases as the frequency is increased. At very low frequencies the brightness is almost proportional to the frequency, but at higher frequencies the rate of increase in brightness becomes progressively less until finally the brightness becomes independent of any further increase in frequency. These features are illustrated in Fig. 6. The brightness is affected also by the temperature at which the cell is operated. With the zinc sulphide phosphors usually used the brightness increases steadily if the temperature is raised from ambient to 100°C or more. A maximum

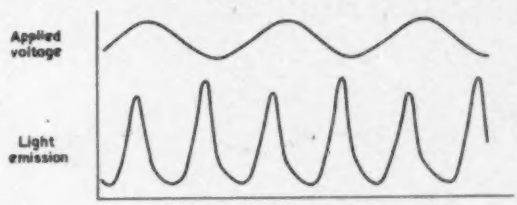


Fig. 4. Brightness waveform for sine waves

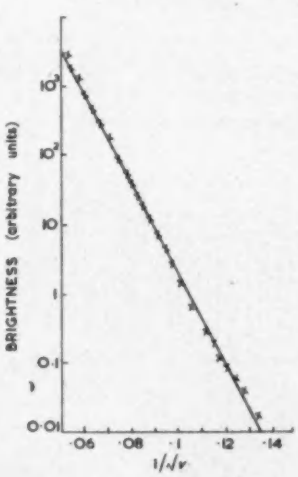


Fig. 5. Cell brightness as a function of voltage for sine waves

brightness is obtained at some higher temperature. This maximum occurs at a temperature which depends on the frequency of the applied voltage, and is lowest for low frequencies.

Another interesting feature of the light emission is that when an alternating voltage is applied to an electroluminescent cell that has been rested for a long time, the peaks of the brightness waveform gradually increase in amplitude until they reach a constant value. This transient behaviour, illustrated in Fig. 7, lasts for only a short time; 10 to 100 cycles for different phosphors under various conditions. During the first half-cycle there is no emission; during the second there is a small output, and with each succeeding half-cycle the peaks increase in amplitude, until they reach an equilibrium value.

The Mechanism of Electroluminescence

With the help of a simple model of an individual phosphor crystallite it is possible to give a satisfactory non-mathematical description of the mechanism of electroluminescence. In Fig. 8 the phosphor particle is regarded as being divided into regions (1), (2), (3) and (4). When a voltage is applied with the polarity shown, a potential barrier in the vicinity of the cathode increases in height

so that a relatively large proportion of the voltage is dropped across it. The field strength within this thin barrier layer (1) becomes very much greater than the average for the crystal. Conduction electrons in the layer will be accelerated so rapidly that some of them can reach energies high enough to ionize any activator atoms with which they may collide. The electrons, their number increased by the addition of secondaries which result from the ionizing collisions, pass out of region (1) into the low field region (2), where they slow down and drift towards region (3). They are rapidly captured by electron traps and a space charge builds up which opposes the applied field. When the polarity of the applied voltage is reversed, the electrons in region (2) return to (1), which is now a region of low field strength, where they may recombine with the ionized activators with emission of light. The space charge field now is of the same polarity as the applied field. It assists in the release of electrons from traps (a process which is dependent mainly on the thermal vibrations of the crystal lattice) as well as in their return to region (1). If an alternating voltage is applied to the crystal, then during one half-cycle the activators can be ionized, and during the next there is emission from them. Exactly similar events are occurring in regions (3) and (4) so the barriers at (1) and (4) grow and decay on alternate half-cycles; while the ionization is being replenished at one side of the crystal, emission is occurring from the other side.

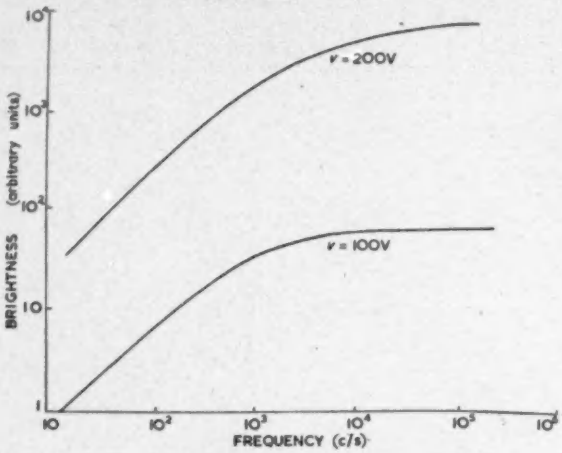


Fig. 6. Cell brightness as a function of frequency

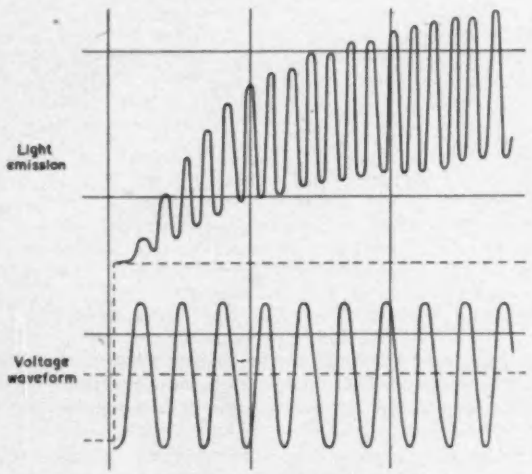


Fig. 7. Build-up of electroluminescent emission

This model can be used to account for the 'build-up' of the brightness. If the phosphor has not been energized for a long time all the electron traps will be empty, and none of the activators will be ionized. On the first half-cycle of the applied voltage there can be no recombination occurring, and hence no light is emitted. But in the cathode region, conduction electrons will be accelerated and will ionize some of the activators. During the next half-cycle some of these electrons can return and recombine, so there will be a small light pulse. But during this, and the next few cycles, a large proportion of the electrons which become available will be trapped and will contribute to the building up of the space charges in regions (2) and (3). The rate at which they are released from traps is directly proportional to the number of filled traps. The traps will go on filling up, and the rate of release for recombination will go on increasing until the number of recombinations in one half-cycle just equals the number of activators ionized in the previous half-cycle. Thus the brightness of the emission will increase from zero to a value which is directly related to the equilibrium value of the space charge within the phosphor particle.

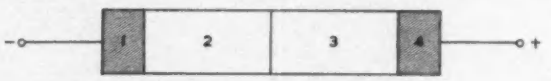


Fig. 8. Model of an electroluminescent crystal

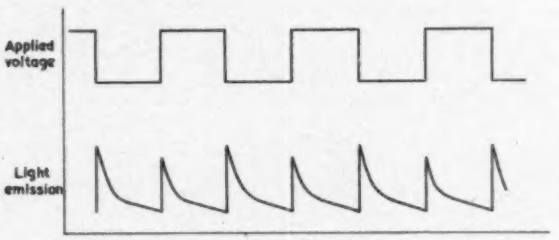


Fig. 9. Brightness waveform for square wave excitation

A mathematical analysis of the barrier layer has shown that the number of ionized activators will be related to the applied voltage by an equation which has the same general form as equation (1). The model does, therefore, provide a satisfactory explanation of the observed dependence of the (equilibrium) brightness of a cell on the amplitude of the applied voltage.

Square-Wave Excitation of the Electroluminescent Cell

When square waves are used to energize an electroluminescent cell, the brightness obeys similar laws to those observed for sine waves. The variation with voltage amplitude can be represented by an equation of the form of (1), and the variation with frequency gives a graph like that in Fig. 6. The build-up phenomenon is observed, and alternate light pulses are slightly different in amplitude. However, the waveform of the light pulses is very different and has some interesting features. As Fig. 9 shows the leading edges of the light pulses rise very rapidly and correspond very closely to the edges of the voltage waveform. The pulses decay more slowly.

When square waves of constant amplitude are applied

to a cell, the amplitude A of the light pulses varies with the frequency in a way which is illustrated in Fig. 10. The maximum is broad and its position varies slightly from cell to cell, but it usually occurs at a frequency between 1kc/s and 2kc/s. At a constant frequency the variation of A (like that of the average brightness) with voltage, conforms with equation (1).

The decay of the light pulse is not exponential, so it has no unique time-constant, but it is useful to define the decay time T as the time required for the light emission to fall from its maximum to 1/3 of this value. At room temperature T is not noticeably affected by the amplitude of the square wave, but it varies within wide limits as the frequency is varied, and it increases as the temperature is raised. At all temperatures T decreases as the

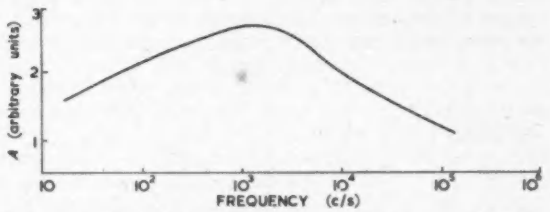


Fig. 10. Amplitude of the light pulse as a function of frequency for square waves

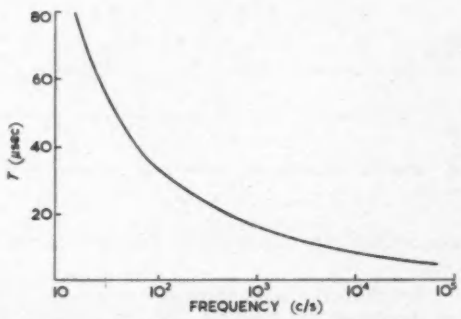


Fig. 11. Decay time as a function of frequency for square waves

frequency increases. There is a variation from cell to cell with an average at 20°C of 4μsec at 50kc/s, and about 100μsec at 20c/s. In Fig. 11 T has been plotted against frequency for a typical cell.

Rise-Time of the Light Pulses

Fig. 12 shows the rising edge of a light pulse on an expanded time-scale. Emission always starts during the time when the applied voltage is changing polarity. For fast-rising square waves of voltage (with rise-times of 0·2 to 0·3μsec) the delay between the onset of the voltage edge and the start of the light pulse may be as little as a few hundredths of a microsecond. The rise-time of the light pulse can be defined as the time for the emission to increase from 0·1A to 0·9A. At room temperature this is less than 0·2μsec for frequencies of 2kc/s and above. At lower repetition frequencies and higher temperatures it increases and is, for example, about 0·6μsec at 50c/s and 60°C.

Secondary Pulses

The waveform shown in Fig. 9 is typical of the light pulses obtained when cells are excited by square waves at frequencies up to a few kilocycles per second. At higher frequencies a small peak appears just before each main peak, as shown in Fig. 13. As the frequency is increased the subsidiary peak becomes more prominent although its duration of about 0·1μsec does not change significantly. This subsidiary peak can be identified with the secondary pulse which has been observed in the light waveforms from a cell excited by a sinusoidal voltage. Because of the nature of the brightness waveforms it is easier to study with square waves of voltage and some of the features which have been noted are:

(1) The secondary pulse starts during the delay period between the start of the rising edge of the voltage, and the start of the main peak in the light waveform.

(2) At elevated temperatures it can be observed with square waves of much lower frequencies.

(3) Each secondary pulse is emitted from the same side of the crystal particles as the preceding main peak.

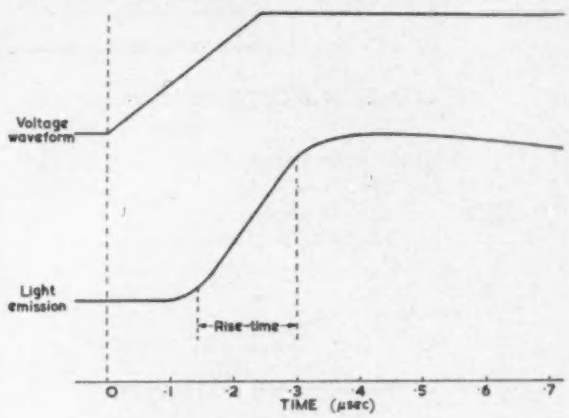


Fig. 12. Rising edge of a typical light pulse

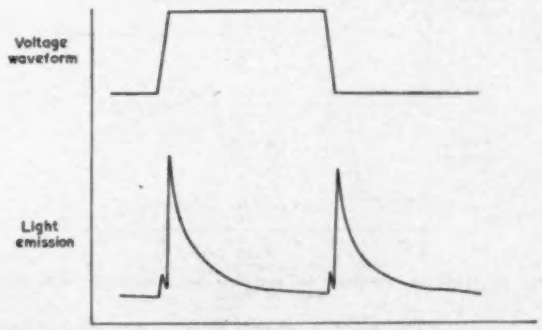


Fig. 13. Light pulses from 50kc/s square wave showing secondary peaks

Evidently it is associated with the changing polarity of the electric field at the end of each half-cycle, and it is believed to be connected with trapped electrons which have failed to recombine after returning to the region of the ionized activators. If they have 'overshot' the activators before being trapped they will be able to reach them only by diffusion after thermal release. But when the field is reversed they will be assisted in their return and may then recombine. The increased amplitude at high frequencies results from the shorter duration of each half-cycle.

Pulse Excitation of Cells

When an electroluminescent cell is energized by repetitive pulses of voltage the light pulses corresponding to the two voltage edges will differ in amplitude and in their rates of decay. Typical waveforms are shown in Fig. 14. The amplitudes A_1 and A_2 of the pulses corresponding respectively to the leading and trailing edges of the voltage pulse, both vary with the voltage in accordance with

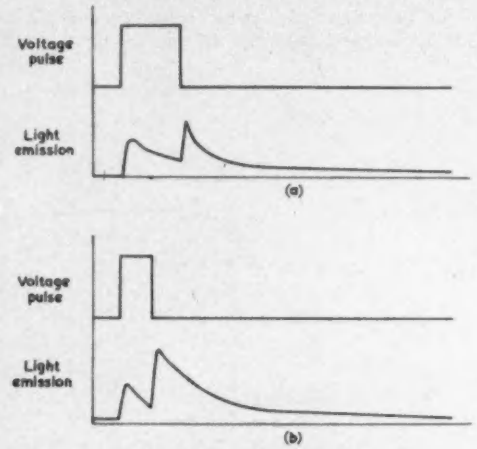


Fig. 14. Brightness waveforms for pulse excitation

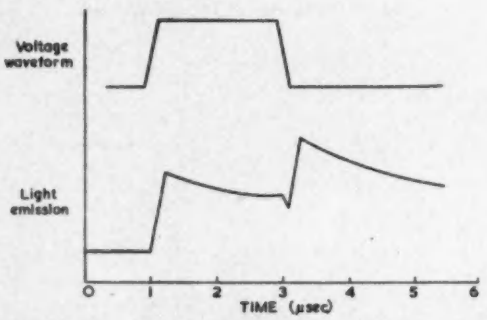


Fig. 15 Brightness waveform for excitation by pulses 2μsec wide at a p.r.f. of 5kc/s

equation (1). The light pulses are similar in shape to those obtained with square waves, and the rise-times are of the same order of magnitude. A_2 is always greater than A_1, but even when the pulse occupies only one five-thousandth part of a complete period (for example when the pulse width is 10μsec and the repetition frequency is 20c/s) A_2/A_1 may be only between 2 and 3.

The decay time T_2 of the second pulse is almost independent of the repetition frequency, and is (at room temperature) about 3μsec for a 20μsec pulse, and 8μsec for a 200μsec pulse. At low repetition frequencies T_1 is always greater than T_2. For example at 50c/s the ratio T_1/T_2 may be about 10, and it decreases to unity as the frequency increases to the value at which the voltage waveform becomes a symmetrical square wave.

When very narrow pulses of voltage are used (i.e. pulse widths of 1 to 5μsec) the light pulse may show a pronounced decrease in amplitude, lasting about one tenth of a microsecond, before A_2 starts to rise. This 'inhibition' (shown in Fig. 15) can be expected to occur whenever the electric field inside the crystal changes polarity while the emission from one side (region (1) in Fig. 8, say) is still of a high intensity. If the decrease in the output from (1) is more rapid than the rise in output from (4), the total output will decrease momentarily, and a notch will appear in the waveform. This condition is most likely to occur when the polarity changes after only a short period of emission has been possible, i.e. at the end of a narrow voltage pulse. The effect is often masked by the appearance of secondary pulses at repetition frequencies above a few kilocycles per second.

Double Pulses of Voltage

If a double pulse of voltage such as is shown in Fig. 16 is applied to an electroluminescent cell, light pulses containing four peaks are obtained. A_2 is the largest peak and it decays most rapidly. When log A_2 is plotted against $1/\sqrt{v}$ (v being the amplitude of the voltage pulse) the points lie on a straight line, so that equation (1) holds

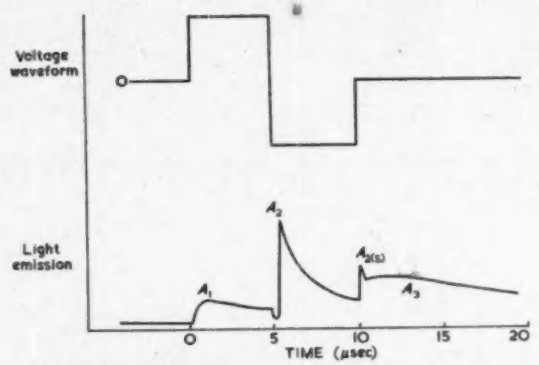


Fig. 16. Brightness waveform for double pulse excitation at p.r.f. of 1kc/s

for this voltage waveshape also. Features of the light pulse are:

(1) That there is a large secondary pulse $A_{2(s)}$ which is very prominent at low repetition frequencies when it may even be greater in amplitude than the primary A_2 peak.

(2) A_2 rises very slowly and has no real peak at low frequencies, but at high frequencies it is comparable in amplitude to A_2, and rises rapidly enough to mask $A_{2(s)}$.

Conclusion

Other more complicated voltage waveshapes can be applied to cells and light waveforms of greater complexity are obtained. It is not possible to account in detail for these or even for the comparatively simple cases discussed in the foregoing sections. It is, however, possible to obtain a qualitative explanation on the basis of the simplified mechanism described (Fig. 8), provided the time-variation of the electric field within the crystal can be calculated. The field will not, of course, vary in the same way as the applied voltage. For example, if a square wave of voltage is applied, the field variation will be in the form of differentiated spikes which decay exponentially with a time-constant which is related to the relaxation time of a phosphor particle. Considerations such as these are beyond the scope of the present article which is intended to give a brief description of the characteristics of electroluminescence, and to serve as an introduction to a discussion of some of the interesting applications of this phenomenon.

(To be continued)

Capacitor Impulse Generators

By E. R. Wooding*

A set of universal curves is given to facilitate calculation of the shape, current, power and duration of the pulse obtained on discharging a capacitor through an inductive load, as for instance, a gas discharge tube used as a high speed light source.

(Voir page 128 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 135)

THE nature of the current pulse obtained by discharging a capacitor is well known but is tedious to calculate. Since capacitor impulse generators are widely used with high-speed light sources[1,2] and in the study of plasma[3,4], the current transients have been obtained in dimensionless form. Universal curves are given which enable the magnitude, shape, duration and rate of change of the current to be calculated with minimum effort.

A capacitor and its load have stray inductance and resistance so that the current in the series discharge circuit varies according to the differential equation:

$$L\,(di/dt) + Ri + (1/C)\int idt = 0 \quad \ldots\ldots\ldots \quad (1)$$

This equation is solved in standard texts[5,6]. However, a dimensionless form is preferable and is easily obtained.

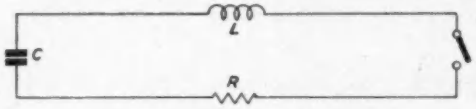


Fig. 1. Equivalent circuit

The RLC Circuit

The Dimensionless Equation

When a capacitor is discharged through a gas-filled tube, the circuit is assumed to be that shown in Fig. 1. Breakdown of the gas is equivalent to the closure of a switch whose conductance changes instantaneously from zero to an infinitely large value and the gas discharge is assumed to behave as a constant ohmic resistance. The inductance, resistance and capacitance distributed through the circuit may be lumped together in L, R and C. A dimensionless equation is obtained by substituting into equation (1):

$$i = IV_o\,(C/L)^{\frac{1}{2}} \quad \ldots\ldots\ldots\ldots \quad (2)$$

and:

$$t = \tau\,(LC)^{\frac{1}{2}} \quad \ldots\ldots\ldots\ldots\ldots \quad (3)$$

where V_o is the potential difference across the capacitance when $t = 0$. The quantities I and τ will be referred to as reduced current and reduced time. Then equation (1) becomes dependent on a single parameter α,

$$(dI/d\tau) + 2\alpha I + \int I d\tau = 0$$

where $\alpha = R/2\,(C/L)^{\frac{1}{2}}$.

This is solved with the initial conditions $I = 0$, and unit charge on the capacitor (dimensional value CV_o) at $\tau = 0$.

The current is oscillatory and exponentially damped when α is less than unity.

$$I = -(1/\beta)\exp(-\alpha\tau)\sin\beta\tau \quad \ldots\ldots\ldots \quad (4)$$

where $\beta = (1 - \alpha^2)^{\frac{1}{2}}$.

The current is critically damped when $\alpha = 1$; then:

$$I = -\tau\exp-\tau \quad \ldots\ldots\ldots\ldots \quad (5)$$

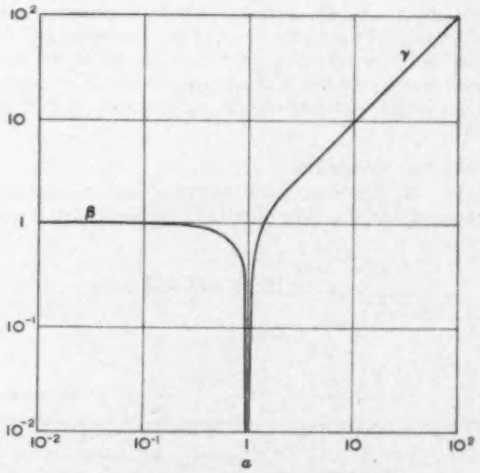


Fig. 2. The parameters β and γ

and is overdamped when α is greater than unity.

$$I = -(1/\gamma)\exp(-\alpha\tau)\sinh\gamma\tau \quad \ldots\ldots\ldots \quad (6)$$

where $\gamma = (\alpha^2 - 1)^{\frac{1}{2}}$.

The secondary parameters β and γ are plotted against α in Fig. 2.

Weedon[7], with the aid of a DEUCE computer has calculated the dimensionless discharge current for 151 values of a parameter equal to α^{-2}.

Current Transients

The reduced current has been calculated for values of α between 10^{-2} and 10 and transients are shown in Fig. 3. These are universal curves so that the current in a given circuit may be obtained from equations (2) and (3).

The reduced peak current I_p is obtained by determining the first maxima of functions (4), (5) and (6). The derivation of these maxima and of other functions which follow will not be dealt with here since these are straightforward, but the relationships obtained are shown in Table 1.

In Fig. 4, peak values I_p of the reduced current are plotted

* *Engineering Laboratory, Oxford, formerly University of Sheffield.*

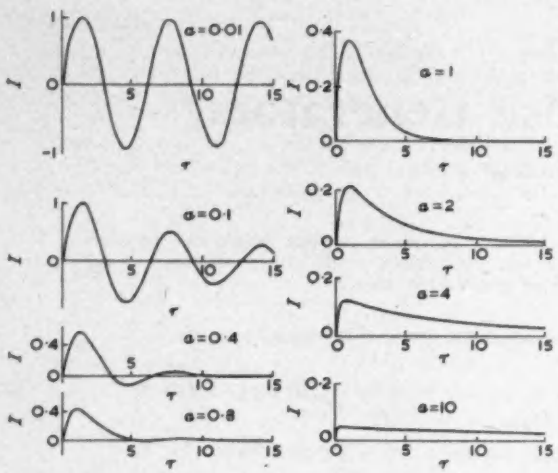


Fig. 3. Variation of reduced current with time

against the parameter α. I_p is critically dependent upon α and is reduced by a factor of 1/7·5 as α increases from 1 to 10, but increases by no more than a factor of 2·4 as α is reduced from 1 to 0·1. Dimensional values of current are obtained from equation (2) in conjunction with Figs. 3 and 4.

Oscillatory Currents

When α is less than unity, positive peaks occur in the reduced current at a time after the first positive peak which is:

$$\frac{2(n-1)\pi}{\beta} \qquad (n = 1, 2, 3 \ldots) \ldots\ldots\ldots (7)$$

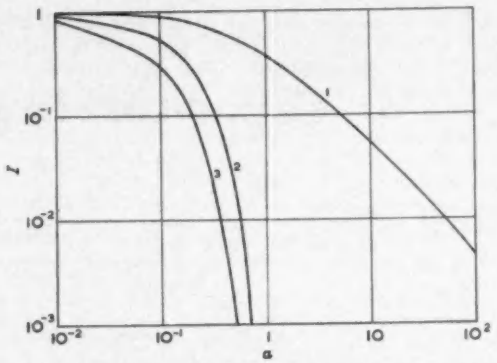


Fig. 4. Reduced peak current and reduced current in (2) second and (3) third positive peaks

and negative peaks occur at times

$$\frac{(2k-1)\pi}{\beta} \qquad (k = 1, 2, 3 \ldots)$$

after the first positive peak. The reduced current at the second and third positive peaks is plotted in Fig. 4 and the reduced time at which they occur is shown in Fig. 5.

The periodicity ω is 2π times the frequency f leading to the relationship for the reduced frequency ϕ:

$$\phi = \beta/2\pi$$

which may be obtained from the values of β plotted against α in Fig. 2. The frequency f is then given by:

$$f = \beta/2\pi\,(LC)^{-\frac{1}{2}}$$

The logarithmic decrement δ of the current is obtained

TABLE 1

Reduced Equations of R.L.C. Circuit

TRANSIENT		RELATIONSHIPS		
		$\alpha < 1$	$\alpha = 1$	$\alpha > 1$
Current	I	$\frac{1}{\beta}\exp(-\alpha\tau)\sin(\beta\tau)$	$\tau\exp(-\tau)$	$\frac{1}{\gamma}\exp(-\alpha\tau)\sinh(\gamma\tau)$
Time to peak	τ_p	$\frac{1}{\beta}\tan^{-1}\left(\frac{\beta}{\alpha}\right)=\frac{1}{\beta}\cos^{-1}\alpha$	1	$\frac{1}{\gamma}\tanh^{-1}\frac{\gamma}{\alpha}=\frac{1}{\gamma}\ln\cdot(\alpha+\gamma)$
Peak current	I_p	$\exp(-\alpha\tau_p)$	$\exp(-1)$	$\exp(-\alpha\tau_p)$
No. of peaks $> I_p/2$	n_i	$1+\frac{\beta}{2\pi\alpha}\ln 2 = 1+0{\cdot}1104\frac{\beta}{\alpha}$	1	1
Rate of change	$\frac{dI}{d\tau}$	$\frac{1}{\beta}\exp(-\alpha\tau)\sin\beta(\tau_p-\tau)$	$(1-\tau)\exp(-\tau)$	$\frac{1}{\gamma}\exp(-\alpha\tau)\sinh\gamma(\tau_p-\tau)$
Initial rate	$\left(\frac{dI}{d\tau}\right)_0$	1	1	1
Rate at $\tau_p/2$	$\left(\frac{dI}{d\tau}\right)_{rise}$	$\frac{1}{[2(1+\alpha)]^{\frac{1}{2}}}\exp\left(\frac{-\alpha\tau_p}{2}\right)$	$\frac{1}{2}\exp\left(\frac{-1}{2}\right)$	$\frac{1}{[2(1+\alpha)]^{\frac{1}{2}}}\exp\left(\frac{-\alpha\tau_p}{2}\right)$
Rate at $3\tau_p/2$	$\left(\frac{dI}{d\tau}\right)_{decay}$	$\frac{-1}{[2(1+\alpha)]^{\frac{1}{2}}}\exp\left(\frac{-3\alpha\tau_p}{2}\right)$	$-\frac{1}{2}\exp\left(\frac{-3}{2}\right)$	$\frac{-1}{[2(1+\alpha)]^{\frac{1}{2}}}\exp\left(\frac{-3\alpha\tau_p}{2}\right)$
Power	P	$4\frac{\alpha}{\beta^2}\exp(-2\alpha\tau)\sin^2(\beta\tau)$	$4\tau^2\exp(-2\tau)$	$4\frac{\alpha}{\gamma^2}\exp(-2\alpha\tau)\sinh^2(\gamma\tau)$
Peak power	P_p	$4\alpha\exp(-2\alpha\tau_p)$	$4\exp(-2)$	$4\alpha\exp(-2\alpha\tau_p)$

from the ratio of the amplitudes of successive positive current peaks, say i_1 and i_2.

$$\delta = \ln (i_1/i_2)$$
$$= 2\pi\alpha/\beta.$$

and is seen in Fig. 6 to rise rapidly as α increases from 0·8 to unity. The current decays more slowly as α decreases, causing an increase in the number $n_\frac{1}{2}$ of positive excursions greater than $I_p/2$, Table 2. The critical value of α causing

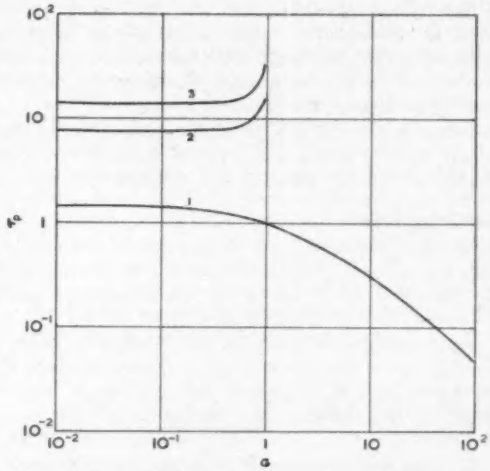


Fig. 5. Reduced time to attain peak current and (2) second and (3) third positive peaks

the current in the $n_\frac{1}{2}$ peak to equal $I_p/2$ is given by:

$$\alpha = \left\{1 + \left[\frac{2\pi(n_\frac{1}{2} - 1)}{\ln 2}\right]^2\right\}^{-\frac{1}{2}}$$

Duration of Transients

There are two useful measures of the duration of the transient; the time t_p taken to reach the peak current and the time $t_\frac{1}{2}$ during which the current is greater than half the peak value, the so called ' half-peak-duration '. The reduced time-to-peak τ_p is that at which the relations (4), (5) and (6) have their first maxima and the time at which the second and third peaks occur is obtained with the aid of relation (7). Values are plotted in Fig. 5 against α and the dimensional form t_p may be obtained from equation (3).

The reduced half peak duration $\tau_\frac{1}{2}$ cannot be obtained analytically but may be approximated when β tends to unity or γ is greater than 5. It is a monotonic increasing function of α when the parameter is greater than unity but is a discontinuous function when the current is oscillatory. The discontinuities occur since $n_\frac{1}{2}$ increases by unit steps as α decreases and $\tau_\frac{1}{2}$ suffers an increment of the order of one period each time α passes through the critical value given in Table 2. The values of $\tau_\frac{1}{2}$ plotted against α in Fig. 7 were obtained graphically from curves such as those in Fig. 3. It is seen that $\tau_\frac{1}{2}$ has a minimum when $\alpha = 0{\cdot}1096$.

TABLE 2
Number of Positive Peaks Equal to ($I_p/2$)

α	$n_\frac{1}{2}$	$\tau_{n_\frac{1}{2}}$
0·1096	2	7·79
0·0551	3	14·10
0·0368	4	20·41
0·0276	5	26·67
0·0221	6	32·97
0·0184	7	39·25
0·0158	8	45·54
0·0138	9	51·82
0·0123	10	58·11
0·0110	11	64·39
0·0100	12	70·67
0·0092	13	76·96

As the parameter α passes through these critical values, $n_\frac{1}{2}$ suffers unit increments and $\tau_{n_\frac{1}{2}}$, the time taken to reach the $n_\frac{1}{2}$ peak, increases by an amount which is of the order of one period.

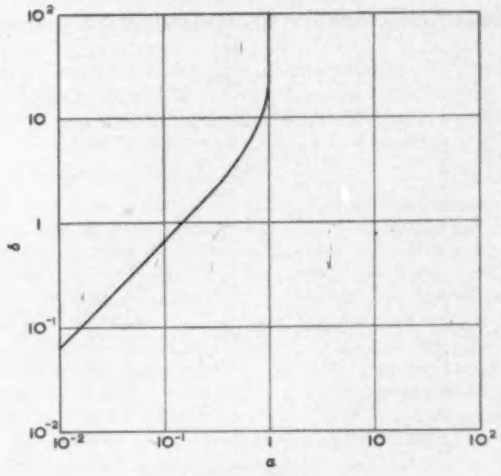


Fig. 6. Logarithmic decrement

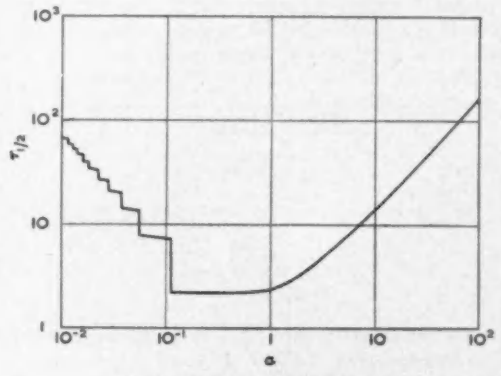


Fig. 7. Reduced half-peak duration

Rate of Change of Current

The rate of change of reduced current may be obtained at any time from the first differential of equations (4), (5) and (6). The rate of rise $dI/d\tau$ at $I_p/2$ would be a useful function, but since there is no relationship for determining the time at which $I_p/2$ occurs, the rate has been determined at $\tau_p/2$ and is plotted against α in Fig. 8. Similarly, the rate of decay could be determined at $3\tau_p/2$ and would be discontinuous when $\alpha < 1$.

The rate of change of current is obtained from equation (2).

$$di/dt = V_0/L \; . \; dI/d\tau$$

The Power Dissipated

The power loss in resistance R is:

$$p = i^2R$$

and by defining effective power p_1 as:

$$p_1 = V_o^2/2\ (C/L)^{\frac{1}{2}}$$

a dimensionless form P is obtained such that:

$$P = p/p_1$$
$$= 4I^2\alpha$$

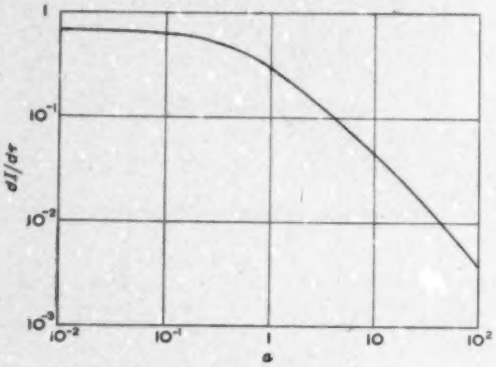


Fig. 8. Rate of rise at $\tau_p/2$

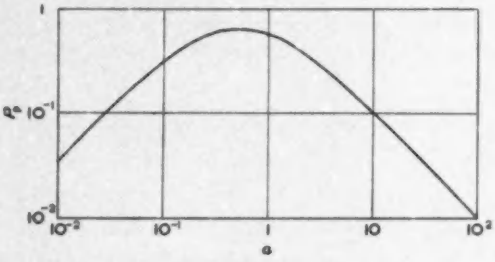


Fig. 9. Peak power

The effective power is the ratio of stored energy $CV_o^2/2$ to the time-constant $(LC)^{\frac{1}{2}}$.

The peak value P_p of the reduced power is found from the values of I_p and α, and is plotted in Fig. 9. The maximum value of P_p occurs when $\alpha = 0{\cdot}5$ and is 0·5962 falling to 0·5414 when α is unity.

The rate of rise of the reduced power may be obtained from the reduced current:

$$dP/d\tau = 8\alpha I\ (dI/d\tau)$$

At time $\tau_p/2$ the rate of rise is 0·7358 when $\alpha = 1$.

The rate of rise of power dp/dt is proportional to V_o^2/L and is a measure of the quality of the circuit, since it is independent of the capacitance, and is useful in comparing capacitors[8].

TABLE 3

Constants of a Given Circuit

PARAMETER	RELATIONSHIPS USED	MEASUREMENT REQUIRED	VALIDITY
α	$\alpha = \delta[4\pi^2 + \delta^2]^{-\frac{1}{2}}$	$i_1\ i_2$	Oscillatory circuit
α	Fig. 8	$\frac{di/dt\ (\text{at } t_p/2)}{di/dt\ (\text{at } t=0)}$	All circuits
L	$L = V_o[di/dt]_{t=0}$	di/dt (at $t=0$)	All circuits
$\sqrt{(LC)}$	$\sqrt{(LC)} = \frac{1-\alpha^2}{2\pi f}$	f	Oscillatory circuits
$\sqrt{(LC)}$	$\sqrt{(LC)} = t_p \pm 20\%$	t_p	$0{\cdot}4 < \alpha < 2$

The Discharge Tube

So far, it has been assumed that the discharge tube behaves as a constant ohmic resistance. In discharges through argon[9] the discharge tube behaves as a non-linear resistor and there is a separation of charge[3] which makes the discharge appear reactive.

The error in assuming R to be a constant ohmic resistance may only be assessed in a given circuit by measuring the electrical characteristics of the discharge device.

Circuit Diagnostics

So far, the aim has been to show how the behaviour of a given circuit may be calculated from a knowledge of the circuit constants. However, it is sometimes useful to be able to estimate the constants of a given circuit.

A rough estimate of the parameter α may be made by comparing the shape of recorded current transients with those shown in Fig. 3. More accurate values may be obtained by calculating δ for oscillatory circuits or the ratio, rate of rise at $t_p/2$ to rate of rise at $t = 0$ (Table 3).

If the inductance is determined from the initial rate of rise knowing V_o, the capacitance may be calculated from f or t_p. Alternatively, the capacitance may be measured[10] and the inductance calculated.

When α, L and C have been determined R may be estimated.

Conclusions

The power, current, duration and rate of decay of the pulse from an impulse generator attain values depending on the relative values of capacitance, inductance and resistance.

It is possible to record a transient and decide with the aid of Figs. 3 to 9 how far short the circuit falls of ideal.

From the calculations made here, it has been possible[8] to specify certain properties of an impulse capacitor.

Acknowledgment

The author gratefully acknowledges the support of the General Electric Research Laboratory of Schenectady. He is indebted to Professor G. Porter for his continuous interest and encouragement and to Mr. Kaye Weedon for criticism and discussion of the calculations.

REFERENCES

1. Vanyukov M. P., Mak, A. A. High Intensity Pulsed Light Sources. *Soviet Physics Uspekhi, 66,* (1) 137 (1958). English translation from *Uspekhi Fizicheskikh Nauk. 66,* 301 (1958).
2. Porter, G. Flash Photolysis and Spectroscopy. *Proc. Royal Soc. A200,* 284 (1950)
3. Porter, G., Wooding, E. R. Radiation from a Pulse Discharge. *Proc. Fourth Internat. Cont., Ionization Phenomena in Gases* (North Holland Pub. Co. 1960).
4. Fischer, H., Mansur, L. C. Conference on Extremely High Temperature (Chapman and Hall, London, 1958).
5. Pipes, L. A. Applied Mathematics for Engineers and Physicists. (McGraw-Hill Book Co. Inc., New York and London, 1958).
6. Ware, L. A., Town, G. R. Electrical Transients (Macmillan & Co., New York and London, 1954).
7. Weedon, K. Fourth International Congress on High Speed Photography, Helwich Verlag Darmstadt 1959, and Private Communication.
8. Wooding, E. R. *To be published.*
9. Mazzucato, U., Wooding, E. R. *To be published.*
10. Webb, J. K., Wood, H. B. The Precise Measurement of Capacitance. *Proc. Instn. Elect. Engrs. 102C,* 3 (1955).

Analogue Telemetry Equipment and Systems

(Part 2)

By S. Poole†, B.Sc., D.L.C., A. Potton*, B.Sc., and C. O. Titley*, A.M.I.E.E.

(Voir page 61 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 66)

The A.W.A. Flutter Dart Programme

As its name implies, this programme of research is concerned largely with 'flutter' and similar phenomena associated with flight at transonic and supersonic speeds.

In particular, a study is being made of flutter and divergence and also control surface characteristics with wings of various designs. The rocket test vehicles are propelled by a 5in solid fuel motor; they are usually fired at low elevation and quickly attain supersonic speed. The wings are instrumented so that their performance during flight can be measured and the necessary telemetry equipment is carried in the forward compartment of the model. Fig. 7 shows a complete model together with its external supply and test unit. A regular programme of flight trials is at present being carried out on these models in conjunction with the Royal Aircraft Establishment.

Instrumentation

Three types of instrumentation are fitted to the wings, according to the purpose of the trial and the varying wing geometry:

(1) Accelerometers of the variable inductance type can be housed within the wing structure to measure acceleration levels occuring during flutter or divergence. These accelerometers are of the conventional pattern, whose behaviour is well known. In this application they operate in ranges up to $\pm 17g$ and are calibrated before installation by being subjected to steady accelerations on a rotating table.

(2) Wing control surfaces are designed such that the hinge stiffness and degree of mass balance may be varied. Aileron movement is indicated by means of a variable inductance type transducer, specially designed and built for this purpose. A coil with an 'E' shaped core is attached to the fixed part of the wing and a moving 'I' piece associated with it is attached to the arm supporting the aileron. In this way, aileron movement results in a varying inductance, the sensitivity depending on the gap distance between the 'E' and 'I' pieces. This is variable and up to $\pm 5°$ of aileron movement have been measured in this way, the transducer assembly having been calibrated before flight.

(3) Strain gauges can also be fitted to the wing structure at any designed point to measure strain levels and monitor wing movement. Associated with these gauges and housed in the telemetry compartment of the model are the necessary battery supplies for the gauges, bridge networks of resistors and set-zero potentiometers which together make up the conventional strain gauge circuits. The voltage output from such networks is of course very small and amplification is necessary before passing the signal into the sender equipment. To meet this need a low drift d.c. transistor amplifier has been designed and is used with gain values up to 100. Its construction is in the form of a Fluon (p.t.f.e.) block with all the components housed in holes drilled in the block. The amplifier is powered by two 4½V batteries, weighs approximately 50g and measures 7cm by 2½cm by 2½cm. This amplifier can be used either to amplify individual channels before sampling or to amplify a sampled output from a switch motor (sampling technique described later).

Telemetry Equipment

The outputs of the instruments as described above are 'seen' by the modulator of the f.m./a.m. sender as either variable voltages or inductances. The various instrument channels are sampled by a 24 segment mechanical switch motor running at a speed of 100 rev/sec for time division multiplex working. Fig. 8 shows the basic system used.

As the total number of channels in any of these models is usually considerably less than 24, segments may be connected together, thus utilizing all switch positions and enabling a much higher sampling rate to be achieved than the nominal 100c/s of the switch wiper rotation.

The sub-carrier produced by the modulator is a sine wave whose frequency is determined by the parameters of the channel to which it is connected by the sampling switch at any particular instant. As indicated earlier, the modulator is capable of accepting either 'voltage' or 'inductive' inputs, conventional techniques being employed to obtain the modulating action. In the former case a reactance valve arrangement is used, while in the latter the

Fig. 7. A.W.A. flutter dart

† *Formerly Sir W. G. Armstrong Whitworth Aircraft Ltd*

* *Sir W. G. Armstrong Whitworth Aircraft Ltd.*

inductance is switched across the tank circuit of an oscillator.

It is arranged that on switch position No. 1 the modulator output frequency is in excess of the range normally covered by the information channels; this results in a distinct synchronizing/reference signal being produced once per switch cycle. The actual manner in which this fixed reference is obtained depends on the type of modulator and the manner in which voltage limiting, if any, is introduced at the modulator input.

The f.m. sub-carrier (modulator output) is applied to the grid of the u.h.f. oscillator to give amplitude modulation of the transmitted r.f. energy; the disk seal triode of this stage being used with a Lecher line to form a conventional Colpitts oscillator circuit. The standing bias on the oscillator grid is such that it is normally biased off; it is only allowed to oscillate at r.f. for a portion of each sub-carrier cycle, i.e. that which raises the grid voltage above cut-off. Thus the oscillator gives bursts of u.h.f. output, these bursts recurring at the sub-carrier frequency as determined by the content of the input information.

The r.f. output is radiated from two spike aerials on the skin of the missile, the lengths of the feeders to the aerials being chosen so that they are fed in anti-phase and so together constitute a half-wave dipole.

The mark-to-space ratio of the output signal may be varied by adjustment of the oscillator grid resistor; the ratio is usually of the order of 1:1 and the pulse power output is approximately 1W. In such applications space for the telemetry equipment is at a premium and design has to be carried out under a severe limitation, due to the need to keep dimensions to a minimum. In this particular case the equipment is grouped on a narrow tray which slides into a 25in long cylinder with an internal diameter of 4½in; and all the sender components together with the batteries which provide internal supplies during flight are mounted upon this tray.

H.T. supplies to the oscillator and modulator are derived from dry batteries, while the heater and switch motor are supplied from silver-zinc accumulators. All these supplies are brought out on one side of a supply socket, which is flush with the skin of the model. Corresponding connexions on the other side of the socket lead to the telemetry equipment itself. Normally the two sets of connexions on the sides of the socket would be connected together, but they are kept apart either by spacers during storage or by the insertion into the socket of an external supply plug. This plug brings the external supplies to the telemetry equipment side of the supply socket for testing, while the model is on the launcher. At a given time before firing, the supply plug is ejected pneumatically and thereafter the internal batteries provide all the supplies.

For such work it is obvious that the utmost reliability must be obtained from the equipment. In order to achieve this, comprehensive testing is carried out at all stages during manufacture and right up to the final moment of firing. Environment checks are made of the final assembly to simulate flight conditions, and typical of this is a drop test which subjects the equipment to a shock of some 40*g*.

Flight trials can only be held at missile ranges provided with specialized facilities such as appropriate launchers with power supply connexion, firing etc., carried out by remote operation; and also optical tracking and photographic facilities. In addition, complete receiving and recording installations have to be provided to enable monitoring and checking to be carried out during both pre-flight testing and also during the trial itself.

It will be clear that the information has ultimately to be presented as a separate indication for each of the instrumentation channels. The receiving equipment consequently has to produce a process which is the reverse of that which takes place in the sender. Thus the signal received from the model is demodulated and this output fed to a discriminator which produces an output whose instantaneous value is dependent on the sender modulator frequency. The discriminator output may be displayed on a cathode-ray tube which has its time-base locked to the sampling switch speed by means of the synchronizing signal. It will be realized that the display waveform will appear as a series of steps (the 'histogram'), the duration of each step corresponding with an information channel period and the amplitude of the step relative to a suitable datum being indicative of the information. During the flight of the model a film record of a complete histogram can be taken, and also each channel can be 'strobed out' or selected to obtain separate records if desired.

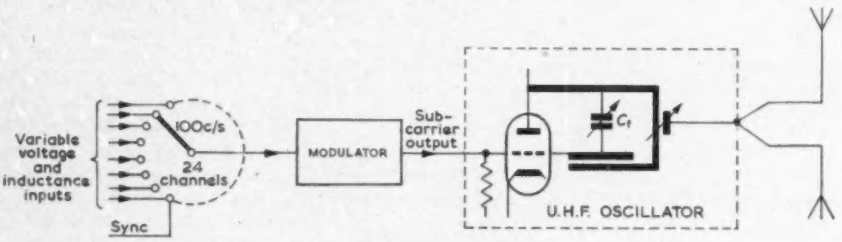


Fig. 8. The telemetry system

The A.W.A. 'Didas' Telemetry Equipment

It has been considered for some time by A.W.A. that an analogue telemetry system of the same general pattern as that used for the Flutter Dart, for example, could be used in the development testing of motor vehicles. There would appear to be definite advantages in such an application because the vehicle can be subjected to the conditions encountered with various types of road surface, etc., while records can be made by equipment of the complex laboratory type which cannot be carried in the vehicle itself. Thus, with a relatively small installation in the car or similar vehicle, records will be obtained under conditions which would otherwise only be possible with a simulator test rig in the laboratory, which in turn is far from representative.

While the general requirements for an automobile telemetry system are similar to those for a test rocket, a number of differing techniques are needed for the two schemes. Also, one major difference is that the long-term stability performance has to be even better for the motor vehicle than for the rocket.

The representative 'commercial' telemetry system described here is a development which has been producd with the automobile industry in mind. Furthermore, the design was carried out in the light of the consideration that the eventual user would probably be a mechanical engineer with little or no knowledge of electronics. Consequently

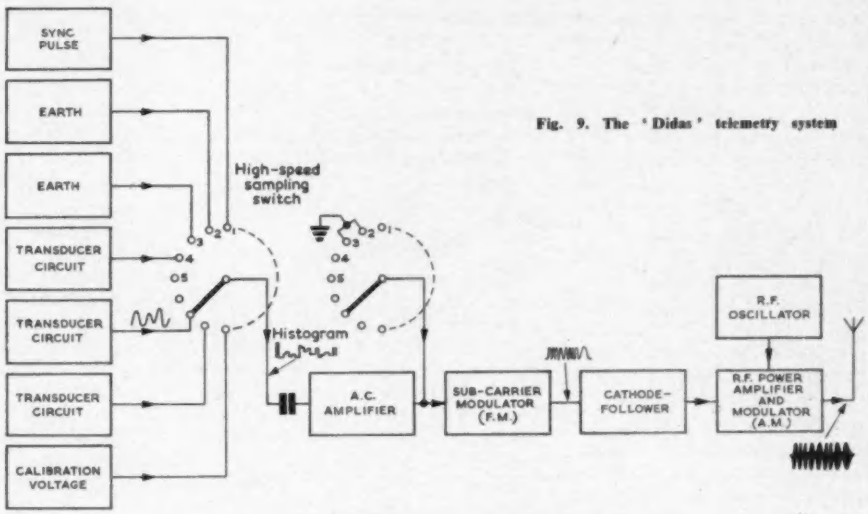


Fig. 9. The 'Didas' telemetry system

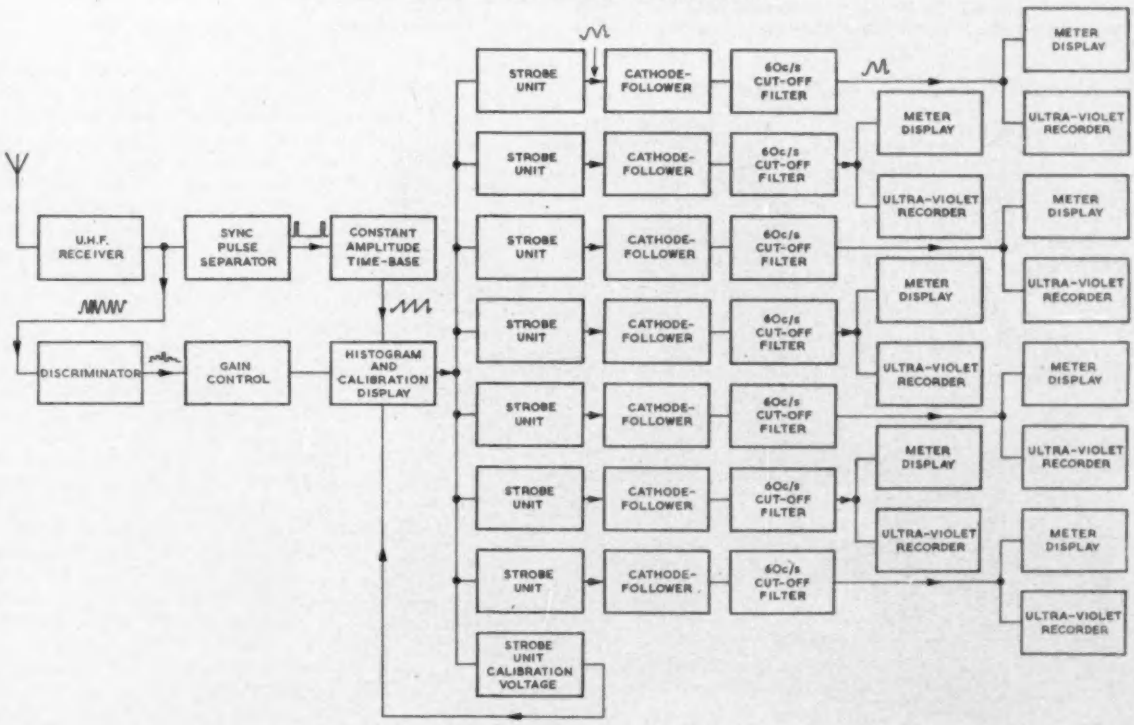
great care was taken that the minimum of adjustment was required, and long term overall drift was maintained at a low value. It was also felt that the commercial user of telemetry equipment would not wish to install a large amount of receiving and recording equipment, from the point of view of cost, and this gear was made as self-contained and simple as possible.

Instrumentation

As part of the development programme, discussions were held with various potential users, and it became obvious that the equipment would have to be extremely flexible with regard to the types of transducer inputs which would have to be accepted by the telemetry sender. For a given vehicle the transducers used may include strain gauges, thermocouples, thermistors, pressure gauges, accelerometers, etc. Therefore, using the time division multiplexing, the primary requirement in maintaining flexibility is that the rest of the sender generally must accept a wide variety of information signals without introducing appreciable inaccuracy.

The final arrangement which was adopted with this end in view employs an a.c. amplifier with a second bank on the sampling switch, which provides d.c. restoration at the amplifier output, as shown in the block diagram (Fig. 9). This technique avoids the use of a conventional d.c. amplifier which can be a major source of drift relative to a 'zero' datum. The a.c. amplifier is transistorized and has a gain of 500, stable to within 0·4 per cent per 10°C over the range 0 to 100°C. This drift, together with any change in the sensitivity of the modulator is, however, compensated within the receiver, as described later in the article.

Fig. 10. The 'Didas' telemetry receiving installation



After amplification, the signal modulates the frequency of a sub-carrier oscillator, using a reactance valve in the normal manner. The sub-carrier oscillator output amplitude modulates the transmitter, which consists of two G.E.C. type A1714 triodes, operating in a Lecher line 'push-pull' oscillator circuit. This oscillator drives a power amplifier, employing a Mullard QQV02-6 double-beam tetrode, also in a 'push-pull' configuration. The sub-carrier oscillator output is fed to the cathode of the power amplifier via a cathode-follower.

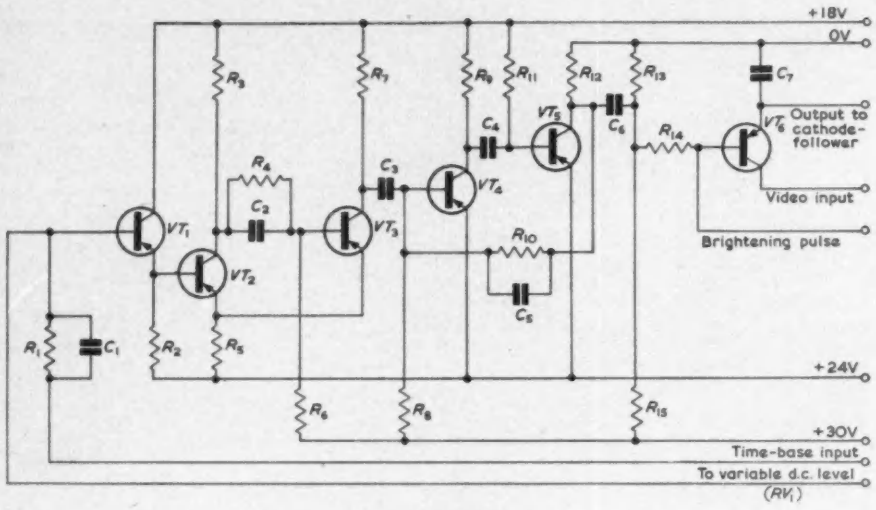


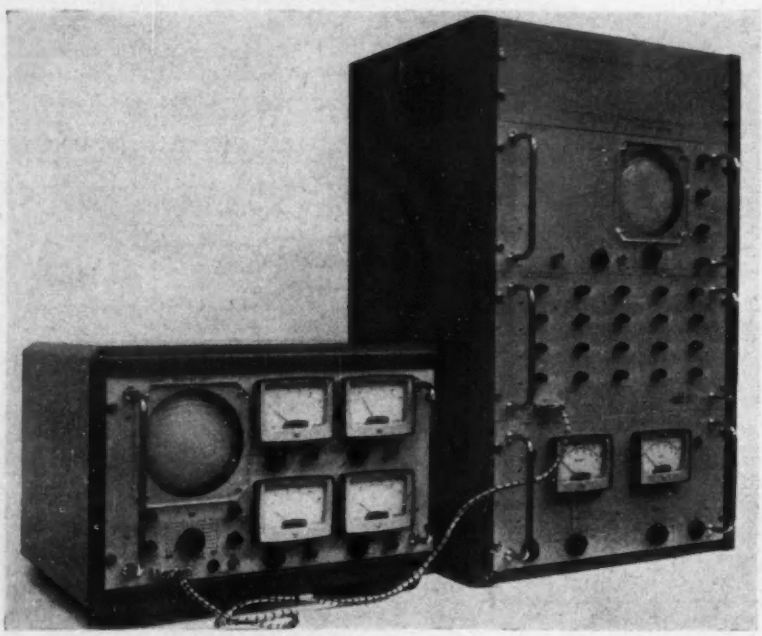
Fig. 12. The strobing unit

A maximum of 3·5W mean power may be obtained from the transmitter, the output from which is fed to a spike aerial which is usually situated on the roof of the vehicle under test.

All h.t. and heater supplies for the modulator and transmitter are obtained from the vehicle batteries. The positive h.t. rail is fed from a transistorized stabilizer. The whole of the d.c. convertor and stabilizer unit is potted in loaded silicon rubber, which has adequate thermal conductivity for this application.

Although space is not at such an absolute premium as in the corresponding rocket test vehicle, every effort has been made to keep the sender as small and light as possible, consistent with accessibility and ease of servicing. The complete unit occupies a space of approximately 1ft³, and weighs about 30 lb.

Fig. 11. The receiving units



Receiving Equipment

A block diagram of the telemetry receiving installation is shown in Fig. 10, while Fig. 11 is a photograph of the receiving units.

Generally the receiving aerial is given some directivity, but may have to be omnidirectional for certain test track configurations. Most work to date has been carried out with the receiver aerial consisting of a folded half-wave dipole with a single reflector. The aerial is matched to the receiver at the particular carrier frequency in use.

The receiver employed is a standard A.W.A. u.h.f. receiver, type UR2. A low noise r.f. amplifier is incorporated, using a single A2521 valve which gives a noise temperature of 3 000°K. The overall receiver bandwidth is 4·5Mc/s and the gain about 95dB. The demodulated signal from the receiver passes into a Travis Round discriminator, which is based on the use of two circuits tuned to frequencies equally above and below the centre frequency of the sub-carrier.

After discrimination, the histogram signal is displayed in the usual way on a cathode-ray tube, the time-base of which is triggered from the synchronizing signal.

At this point (post discrimination), channel 2 of the discriminator output is clamped to earth. Since channel 2 is connected to earth at the sender, this eliminates zero drift. Gain drift through the system is compensated by strobing out the calibration channel and observing the output on a meter. The receiver gain control is adjusted so that the strobed output from the calibration channel is always main-

tained at a constant value. These two safeguards keep long term zero drift and gain drift to a minimum.

In order that the demultiplexing circuits can operate successfully, it is necessary that the triggered time-base should have an extremely constant amplitude. The normal transitron type time-base is therefore modified to incorporate a feedback loop which holds the time-base waveform to a constant amplitude.

This constant amplitude time-base is fed to the input of the strobing units, the circuit of which is shown in Fig. 12. The time-base is a.c. coupled into the unit and a d.c. level is then set up by means of the potentiometer RV_1. VT_1 is used as an emitter-follower which drives the Schmitt trigger circuit made up of VT_2 and VT_3. The output from the Schmitt trigger is in the form of a square wave, with a repetition rate fixed by the time-base frequency, to which it is locked, and a mark-to-space ratio controlled by the potentiometer RV_1. Capacitor C_3 and resistor R_8 comprise a differentiating circuit which reduces the square wave output from the Schmitt trigger to a positive and negative going pulse. The positive going pulse is used to trigger a single shot multivibrator. This results in the generation of the square topped gating pulse which may be moved to any point along the time-base by means of RV_1.

In order that the position of this gating pulse relative to the beginning of the sampling switch cycle may be known, the pulse is fed to the grid of the display tube, which causes the trace to be brightened at the particular channel which is being strobed, and thus enables the strobing pulses to be positioned accurately.

Transistor VT_6 is a gating transistor which is normally cut off. When the gating pulse from VT_5 is applied to the base of this transistor it is 'turned on' and thus any selected part of the discriminator output may be strobed since the collector and emitter are at the same potential for the duration of the gating pulse. Capacitor C_7 holds the voltage at the emitter of the gating transistor constant between strobing pulses. In order that the voltage at the emitter of VT_6 does not decay excessively between the arrival of successive strobing pulses the gate must feed into a high resistance.

It is not practicable when using transistors to achieve sufficiently high input resistance without excessively complex circuits, and therefore a thermionic valve cathode-follower is employed at this point.

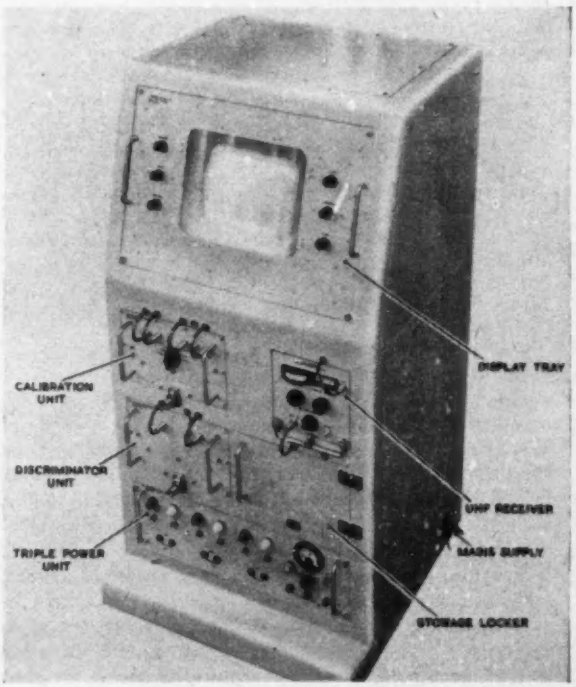
It will be apparent that the output from this cathode-follower is nevertheless a series of steps.

This stepped output is passed through a low-pass filter with a cut-off frequency of 60c/s. Since the filter removes all frequency components of the input above 60c/s, the stepped nature of the input to the filter is no longer apparent at the output; all the frequency components up to 60c/s, however, appear at the filter output.

After strobing and filtering, the signals are displayed visually and recorded. The visual display consists of a cathode-ray tube with a slow time-base and long persistence phosphor, together with a meter section with a number of meters grouped together on a panel. Rapidly varying quantities such as certain strain gauge outputs are displayed on the cathode-ray tube, which has a time-base frequency variable up to 10c/s. Slowly varying quantities are displayed on individual meters. The recorders used with this system are of the N.E.P. model 1050, ultra-violet type. This type of recorder enables the trace to be examined within seconds of recording.

The telemetry system as described has been extensively tested with a number of different vehicles. It can be claimed that long term stability is excellent with accuracies maintained better than 5 per cent—improvement to 3 per cent should be easily obtained with further development. It has also been found that with a telemetry system of this kind, the records obtained can be used by the mechanical development engineers, who are the 'users', without any difficulty or trouble due to interpretive processes being necessary.

Fig. 13. The telemetry test console



Telemetry Test Equipment

A typical assembly of A.W.A. test equipment is given in Fig. 13 where a console is illustrated embodying a number of units which have been developed for experimental and routine checking applications. Fig. 14 shows the arrangement of a receiver, calibration and display unit, which constitutes one of the most useful tools for use in this field, and is essentially the group of units shown in the photograph.

The most important feature of the equipment is provided by the calibration unit which is a unique feature*. The diagrammatic representation of the face of the display tube shows the simultaneous display of the telemetry histogram and a calibration marker. A marker greatly facilitates the setting of individual channels to specific test levels, as coincidence of channel and an appropriate marker, selected by a switch, gives adequate setting accuracy.

The time-base waveform from the display unit is taken into the calibration unit, differentiated, and used to trigger an Eccles-Jordan circuit. Square pulses generated alternately at the Eccles-Jordan anodes, gate two pentode amplifiers on their suppressors. These are CV2209 (VX6097) type, with short suppressor base, and internal suppressor diode providing a clamp to cathode potential when the valve is 'on'. Signals from these gated amplifiers are mixed in a common load, the output thus consisting of histogram

* *British Patent No. 744,354. Telemetry-Calibration System.*

and calibration frequency alternately on successive time-base sweeps.

The display unit accepts the mixed signal from the calibration unit. It is amplified, limited and fed to a discriminator. This operates at a level high enough to need no further amplification before being applied to the vertical deflector plates of the cathode-ray tube. The d.c. level is thus never lost. A conventional Miller integrator anode-follower time-base is synchronized by a pulse derived from the histogram via a circuit resonant at the synchronizing signal frequency. It is not practicable to do this in the display unit after mixing since every other synchronizing pulse is missing in the composite histogram-calibration waveform.

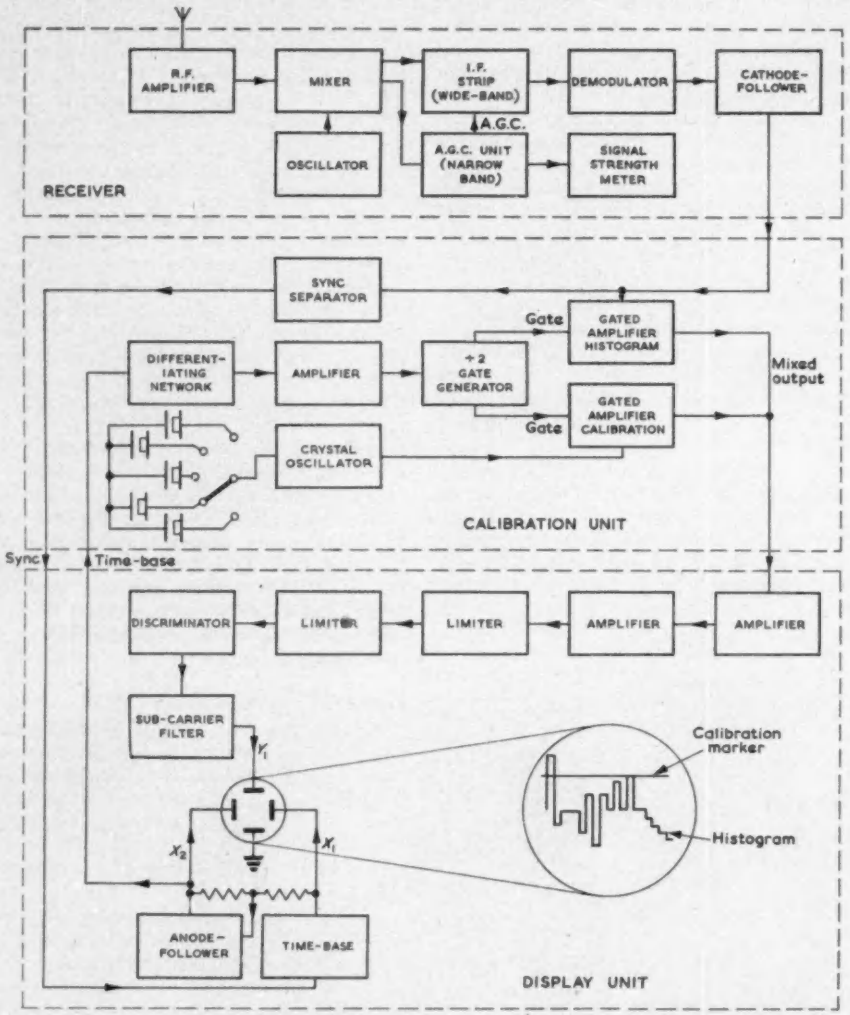


Fig. 14. The telemetry test console

Fig. 16 shows the principle of operation of a directional coupler of the loop type. A current I flowing in the transmission line AB, due to power transmitted from A to B causes an opposing current I_L to be induced in the loop of the measuring line by electromagnetic induction. Similarly the voltage on the main transmission line will cause a current I_c to flow to earth via the distributed capacitance C between main and measuring lines. Because I_L is a circulating current and I_c flows away from the main line in each arm of the loop, the diagram will make it clear that in one arm the currents add, while the resultant in the other is their difference. The design of the loop is such that I_L is equal to I_c, and the measuring loop termination R_1 thus has a potential across it due to $I_L + I_c$. R_2, terminating the other arm of the loop carries no current and has no potential across it. Crystal rectifier meters M_1 and M_2 record the potentials developed across R_1 and R_2 respectively. Thus power transmitted in the direction A to B causes M_1 to read and power in the B to A, or

Directional Coupler

Another item developed for aerial and feeder development and checking is a coaxial directional coupler. Fig. 15 shows a typical instrument which is for insertion in 52Ω line, and has two ranges with full scale values of 1W and 5W repectively.

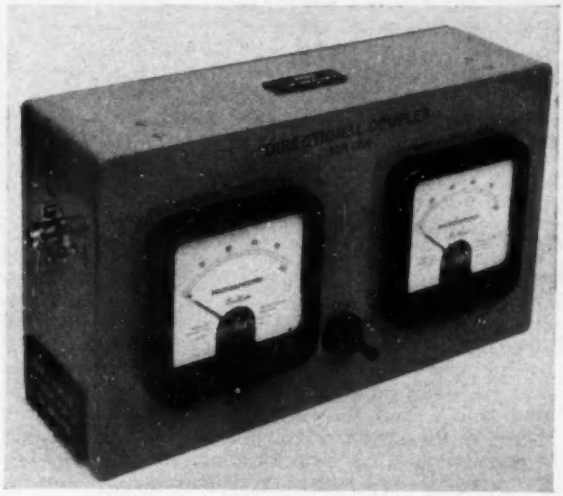


Fig. 15. The directional coupler

backward direction, M_2. The loop, used in this way thus forms a directional coupler, and the meters are labelled 'forward' and 'backward'. As the meter readings are a function of the power flowing in the main line, they may be calibrated in terms of power. Although a given loop assembly will operate over a wide range of frequencies, the power calibration will change with frequency, because the coupling between loop and line varies.

This is a versatile instrument, useful over a wide frequency range, and is convenient because it needs no power

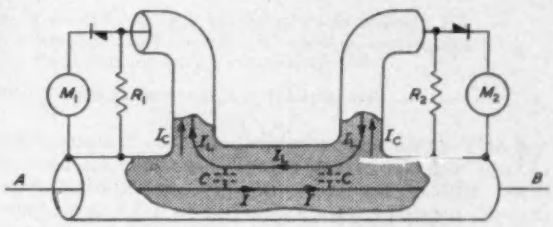


Fig. 16. The principle of the directional coupler

supply, while consuming a negligible amount (typically $1/500^{th}$) of the power transmitted.

Acknowledgments

Acknowledgment is due to the Directors of Sir W. G. Armstrong Whitworth Aircraft Ltd for permission to publish this article.

An X-ray Spectrometer for Space Research

Electronic equipment for one of the experiments to be carried out by the first Anglo-American Scout space research satellite which is planned to go into orbit this year has been designed and manufactured by the Guided Weapons Laboratory of Bristol Aircraft Limited.

The equipment is an X-ray spectrometer developed for the Space Research Group at University College, London, and the Physics Department of the University of Leicester by Bristol Aircraft Ltd. The spectrometer will be used in an experiment to obtain data for the correlation of ionospheric behaviour with solar X-radiation outside the earth's atmospheric shield, and is designed to measure the rate of incidence of X-rays in five energy bands within the range of 2 to 13Å. X-rays are detected by a proportional gas counter which produces pulses whose heights are proportional to the energies of the incident X-rays. The minimum pulse separation is one microsecond.

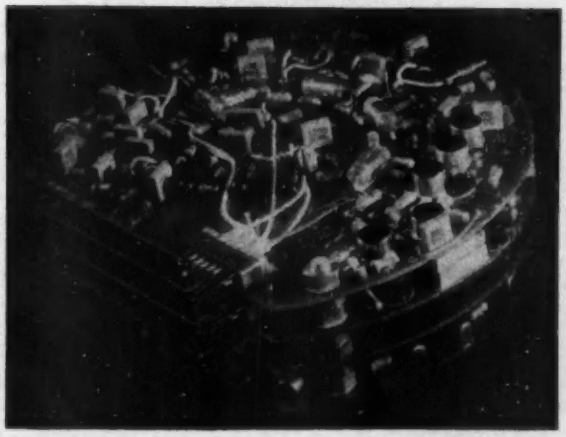
The pulses are amplified by about 72dB in a low-noise, stable-gain amplifier and are then sorted into five energy bands by a pulse height discriminator. The five bands are interrogated sequentially by a gate which is controlled by the satellite's master clock. Each band is interrogated for a period of one second during each cycle of operation. The pulses occurring during each interrogation period are accumulated in a 15-stage binary counter. At the completion of each count, the contents of the counter are transferred direct to the telemetry system for direct transmission to the ground while the vehicle is in contact with ground stations, or for storage on a magnetic tape while it is out of contact with ground stations, so that it can be read when contact is made again.

The equipment is fully transistorized and is designed to operate on less than 100mW of power, which is derived from the satellite's solar cell power system.

The interior electronic equipment, including the spectrometer, is constructed in four 5¼in diameter circular cards or modules, which are encapsulated in polysulphide rubber and the whole is no more than three inches in depth.

UK Scout 1, as the first Anglo-American vehicle is known, weighs 150 lb and will have a 55 degree orbit with a perigee of 200 miles and an apogee of 600 miles. It is expected to have a useful life of about one year.

The spectrometer before encapsulation. In this form it weighs about 310g.



Selective RC Amplifier Using Transistors

By R. Hutchins*, M.Sc.

This article investigates the use of phase-shift networks in transistor circuits. The dual of the Wien bridge arm is used to form an oscillator and a selective amplifier. The selective amplifier described has continuously variable selectivity and tuning while the gain remains constant.

(Voir page 129 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 136)

MANY phase shift networks have been considered for use with valve circuits; the most common are the twin-*T* network, cascaded *RC* sections and the Wien bridge arm. All these circuits are attractive to use because there is in each case a common terminal between input and output. The twin-*T* and cascaded *RC* sections are six element networks which require three ganged components for frequency variation. Although these two networks may be used with transistor circuits to form oscillators, the analysis of the circuits is not easy unless the transistor input

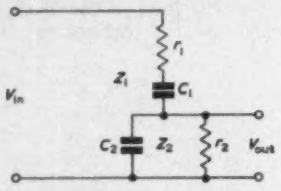


Fig. 1. Wien bridge arm

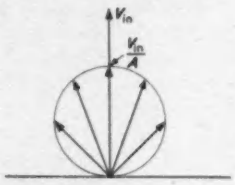


Fig. 2. Locus of V_{out}, Fig. 1

impedance is neglected, either approximated to zero or to an infinite value depending on the type of circuit used; an analysis on these lines is given by Hooper and Jackets[1].

The Wien bridge arm is a four-element network which it is shown can be adapted for use in transistor circuits. This network not only has the advantage of being simpler to analyse than the previous two, but it is also more convenient to use if variable tuning is required, since only two elements need to be varied.

The Wien Bridge Arm

The Wien bridge arm is shown in Fig. 1. For this network, the voltage attenuation is given by:

$$-\frac{V_{out}}{V_{in}} = \frac{1}{A + jB}$$

where $A = 1 + (r_1/r_2) + (C_2/C_1)$

$B = r_1\omega C_2 - (1/r_2\omega C_1)$

The locus of the output voltage with respect to the input is a circle, as shown in Fig. 2. For normal operation in an oscillator, it is required that the above ratio should be real, this is satisfied when B is zero and hence the frequency is given by:

$$\omega_0^2 = \frac{1}{r_1 r_2 C_1 C_2}$$

which is the frequency of zero phase shift.

The Wien bridge arm is not well suited for use in transistor circuits in the same manner that it is employed with valves, because of the high attenuation that would be required to minimize the effect of transistor input impedance. A thermionic valve is basically a voltage controlled device whereas a transistor is current controlled, and this aspect of valves and transistors leads to the principle of duality which has been considered by Wallace and Raisbeck[2]. This principle may be usefully applied to the Wien bridge arm. The dual of the Wien bridge arm is shown in Fig. 3 which contains inductors; this network is not suitable in this form, since one advantage of using *RC* networks is the avoidance of inductors. By replacing the inductors with capacitors, as in Fig. 4, the phase-shifting properties of the network are not destroyed, and

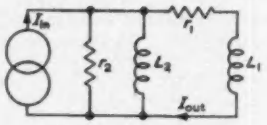


Fig. 3. Dual of Fig. 1

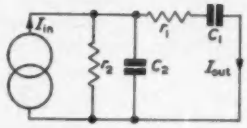


Fig. 4. Modified dual of Fig. 1

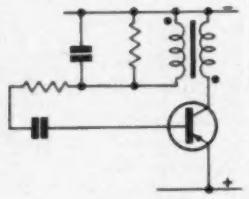


Fig. 5. Oscillator with one transistor (excluding base bias)

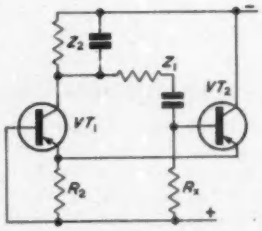


Fig. 6. Two transistor RC oscillator

the expression for current attenuation is the same as for the voltage attenuation of the bridge arm, namely:

$$\frac{I_{out}}{I_{in}} = \frac{1}{A + jB}$$

Application

The simplest application of this circuit using one transistor, requires a phase reversing transformer with the transistor in the common emitter connexion, as shown in Fig. 5, which can be arranged to oscillate. However, it would be preferable to dispense with the transformer at the expense of introducing a second transistor. It would be possible to form an oscillator by feedback through the phase-shift network, from collector to emitter, if there was current gain in the transistor; this requirement can be met by using a second transistor in the common collector connexion. A great advantage of this arrangement is that there is a collector from which an output may be taken, without directly affecting the loop gain. The circuit of Fig. 6 shows how the feedback is connected; the resistor R_x is used to reduce the loop current gain which would otherwise be too high.

* *A.E.I. (Manchester) Ltd, formerly Northampton College of Advanced Technology, London.*

An approximate criterion for oscillation of the circuit may be established by inspection. Assuming that R_x is small compared with the input impedance to the base of the second transistor, and that R_2 is large compared with the emitter input impedance of the first transistor, then the criterion for oscillation can be shown to be approximately:

$$\frac{R_x\alpha_1}{A\,(h_{11(1)} + h_{11(2)})} = 1$$

An alternative analysis from the equivalent circuit is given in Appendix 1, by considering the input impedance to the base of the first transistor. From this analysis, the input impedance is given by:

$$Z_{in} = \frac{1}{(1-\alpha_1)}\left[h_{11(1)} + R_2 - \frac{R_2^2}{h_{11(2)} + R_2}\quad \frac{R_2R_x\alpha_1}{(h_{11(2)} + R_2)(A + jB)}\right]$$

The locus of Z_{in} with frequency is a circle of diameter

$$\frac{1}{(1-\alpha_1)}\left[h_{11(1)} + R_2 - \frac{R_2^2}{h_{11(2)} + R_2}\right]$$

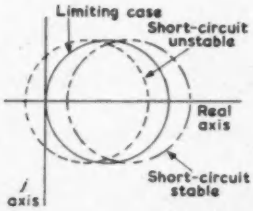


Fig. 7. Locus of input impedance to the base of VT_1 Fig. 6

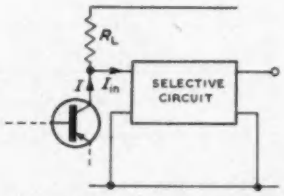


Fig. 8. Arrangement for a selective amplifier

The position of this circle along the real axis varies with the amount of positive feedback, as illustrated in Fig. 7. The position of this locus is shown short-circuit stable, short circuit unstable and in the limiting case; of which the latter is the criterion for oscillation.

The circuit will thus operate as an oscillator when the input impedance is just negative, and the base of the first transistor is earthed (to a.c.). The frequency will be nominally that of the zero phase-shift in the *RC* network.

If the circuit is so adjusted that the loop gain is insufficient for continuous oscillation, then by applying an input to the base of the first transistor, the circuit will respond better at the frequency for which the input impedance is a minimum; that is the circuit becomes frequency selective. Fig. 8 shows a method of driving the selective circuit from the collector of a preceding amplifier. The division of current into the actual selective circuit is thus:

$$I_{in} = \frac{I}{1 + (Z_{in}/R_L)}$$

An interesting case occurs when Z_{in} is set to zero, under these conditions there is no division of current at the selective frequency, and $I_{in} = I$. For frequencies at which B is not zero, then Z_{in} also is not zero, and a current division takes place reducing the input to the selective circuit. With this arrangement, the input current falls by 3dB at the frequencies for which:

$$|1 + (Z_{in}/R_L)| = \sqrt{2}$$

A rigorous solution to find the bandwidth is not convenient because of the complexity of the expressions. The following approximation greatly simplifies the analysis: since the impedance locus where B is zero is a tangent to the imaginary axis (Fig. 7), then the bandwidth will be determined by the imaginary part of Z_{in}. The real part of Z_{in} is negligible for a considerable portion of the circle, and hence the 3dB bandwidth of the input current are the frequencies for which $jZ_{in} = \pm R_L$.

From the expression for input impedance, the reactive component for small values of B can be obtained as:

$$jZ_{in} = \frac{1}{(1-\alpha_1)} \cdot \frac{R_2R_xB\alpha_1}{A^2(h_{11(2)} + R_2)}$$

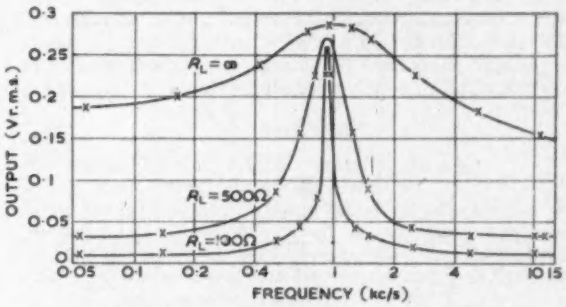


Fig. 9. Frequency response of selective amplifier

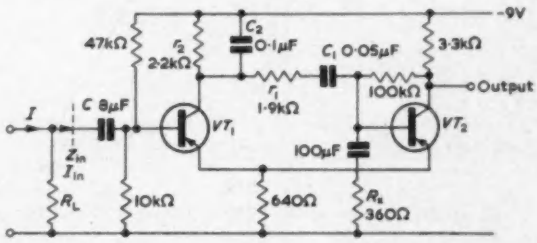


Fig. 10. The selective amplifier tested
$r_2 = 2{\cdot}2k\Omega$
$C_2 = 0{\cdot}1\mu F$
$r_1 = 1{\cdot}9k\Omega$
$C_1 = 0{\cdot}05\mu F$
$R_x = 360\Omega$ *(found by experiment)*
Attenuation Constant $A = 4$

The frequencies for which the input current is 3dB down is thus given by:

$$B = \pm\frac{(R_2 + h_{11(2)})A^2R_L(1-\alpha_1)}{R_2R_x\alpha_1}$$

Solving this expression for the two 3dB frequencies, the selectivity of the input current, $Q = \dfrac{\text{Selective frequency}}{\text{Bandwidth}}$ can be found to be:

$$Q = \frac{R_2R_x\alpha_1}{(h_{11(2)} + R_2)A^2R_L(1-\alpha_1)} \cdot \sqrt{[(r_1/r_2) \cdot (C_2/C_1)]}$$

If $h_{11(2)}$ is small compared with R_2, then this expression simplifies to:

$$Q = \frac{\alpha_1R_x}{A^2R_L(1-\alpha_1)} \cdot \sqrt{[(r_1/r_2) \cdot (C_2/C_1)]}$$

This analysis shows that if the circuit is used as a selective amplifier, and arranged so that the input impedance is zero at the operating frequency by careful adjustment

of the loop gain, then the selectivity of the circuit may be varied by R_L without affecting either the gain or the selective frequency. Furthermore, if the parameters in the RC network are altered, but keeping A constant, then the circuit is is also tunable. The graph of Fig. 9 shows the frequency response of the circuit shown in Fig. 10 for different values of R_L, when the input current is supplied from a high impedance source (I constant). The curve taken with R_L infinite corresponds to a true R_L of about 10kΩ, caused by the bias resistor. The flatness of this curve in the neighbourhood of the selective frequency shows that the selectivity with lower values of R_L is caused

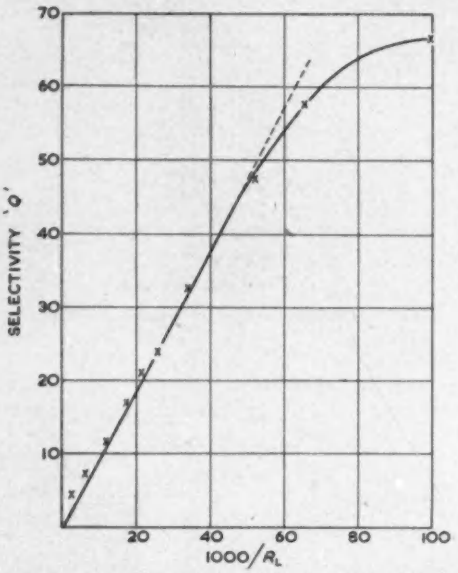


Fig 11. The selectivity against $1\,000/R_L$ for circuit of Fig. 10

solely by the division of current at the input, and not by variation of the current gain. Thus the selectivity of the whole circuit as an amplifier is the same as that given above for the selectivity of the current division.

The graph of Fig. 11 shows the variation of selectivity of the circuit of Fig. 10 against $1\,000/R_L$. It is seen that the points lie close to a straight line which gives the relation $Q = 980/R_L$. Deviation from the line at high values of Q is caused by errors in measurement, and by a slightly imperfect setting of Z_{in} to zero.

Substituting in the expression for selectivity gives the calculated relation $Q = 1150/R_L$. The difference in values is caused by the bias resistor on the base of the second transistor, which modifies the effective value of R_x; also the calculated result was obtained by neglecting the value of h_{11} in the expression for selectivity.

For a given amplifier, the selectivity has been shown to be proportional to:

$$Q \propto 1/A^2 \,.\, \sqrt{[(r_1/r_2) \,.\, (C_2/C_1)]}$$

Substituting $n = (r_1/r_2)$, $m = (C_2/C_1)$, it is found that this constant has a maximum value of 1/8 for $n = m = 1/2$, but departure from these ratios is not critical.

Frequency Limits

The useful frequency range of the circuit is governed by the reactance of coupling capacitors at low frequency, and by the phase shift of the current gain and collector capacitance at high frequency. At low frequency, the capacitor C (Fig. 10) with which the circuit is coupled, adds a term $-j/\omega C$ to the expression for Z_{in}. The presence of this reactive term would normally create an error factor, implying that for the input impedance to be zero, B is not zero. The value of B would be sufficient to cancel the reactance of the coupling capacitor, and would vary with frequency. This error term can be eliminated by choosing a suitable value for the capacitor, C_x, coupling R_x. This makes R_x effectively $R_x - (j/\omega C_x)$, and the reactive term is of the correct sign to cancel the previous one. Substituting the appropriate circuit parameters, it is found that C_x has to be about $12C$ for this cancellation to occur.

At the upper frequencies, the collector capacitance of the first transistor, which is about 300pF for the audio transistors used, can be added into C_2 of the phase-shift network as a parallel combination. In general, however, this value is smaller than C_2 and does not limit the frequency. A more serious limitation of the maximum frequency is

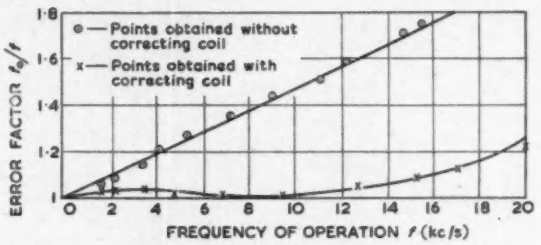


Fig. 12. Variation of error factor against frequency of operation

the phase-shift of the current gain of the transistors. Up to the cut-off frequency of the transistor the current gain follows closely the law:

$$\alpha = \frac{\alpha_o}{1 + (jf/f_\alpha)}$$

where α_o = low frequency gain

f = frequency of operation

f_α = cut-off frequency

This relation can be substituted in the expression for Z_{in}, also the reactive component of h_{11} may be found since $h_{11} = r_e + r_b(1 - \alpha)$; for frequencies small compared with the cut-off frequency, this approximates to h_{11} (reactive) = $h_{11} + (jr_b\alpha_o f/f_\alpha)$.

Substituting the above reactive relations gives the following expression for the input impedance at high frequency:

$$Z_{in} = \frac{1}{(1 - \alpha_1)} \cdot \frac{R_2}{(R_2 + h_{11} + jr_b(f/f_\alpha)\alpha_o)} \left[\frac{(R_2 + h_{11} + jr_b(f/f_\alpha)\alpha_o)^2}{R_2} - R_2 - \frac{R_x\alpha_1}{(A + jB)}\right]$$

Considering the reactive component of Z_{in}, the ratio of the frequency of zero phase-shift in the RC network to the operating frequency of the circuit is $1 + 24(f/f_\alpha)$ for small values of f/f_α, the relevant transistor parameters are:

$$\alpha = 0{\cdot}98 \quad h_{11} = 31\Omega \quad r_b = 840\Omega \quad f_\alpha = 500\text{kc/s}$$

The graph of Fig. 12 verifies this relation experimentally; the experimental results were taken by comparing the operating frequency of a circuit using audio frequency transistors (type OC71) with the same circuit using radio frequency transistors (type OC44), the latter having a much smaller phase-shift. The gradient of the graph is 0·046, whereas the theoretical value is 0·048 from the above

expression; the agreement here is as close as can be expected.

It was shown how at low frequency a capacitor in series with R_x compensates the low frequency error, in a similar manner an inductor in series with R_x compensates the high frequency error. The value of the inductance required is:

$$L = (Ar_b/\pi f_o) + (R_x/2\pi f_o)$$

substituting the above parameters gives the value of 2·15mH. It was found experimentally that an inductance of 2·35mH gave satisfactory results, the improved performance is also illustrated in Fig. 12.

Tuning

In precision valve *RC* oscillators, capacitance tuning is preferred because of the smooth variation of capacitance. However, associated with the small value of continuously

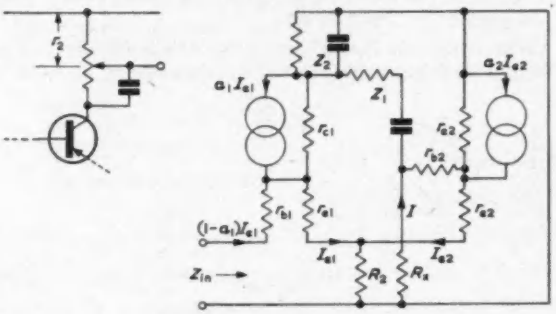


Fig. 13. (left) Resistance tuning with constant collector bias
Fig. 14. (right) Equivalent circuit of Fig. 10

variable capacitance that is convenient, a high impedance *RC* network is required. This arrangement would cause a high current attenuation when used with transistors, and the high gain amplifier which would be required presents additional phase-shift problems.

Although resistance tuning tends to be noisy, it is more compact than capacitance tuning, and can be used to form a low impedance *RC* network which is more suitable for use with transistors. By keeping the impedance sufficiently low, the network can be used in the collector of a transistor, and will be supplied with a constant current from the transistor. Fig. 13 shows how the variable resistance can be used in the collector, without altering the bias voltage of the transistor; r_2 is the portion of the resistor which is relevant for the phase-shift network, the capacitor is added so that the collector output capacitance still appears in parallel with r_2.

Conclusions

It has been shown that a modified Wien bridge arm may be used in a two-transistor circuit to form an oscillator or a selective amplifier. By supplying a current input to a series arm of the circuit, when in a critically stable condition, the selective circuit so formed has the characteristics of variable selectivity with constant gain. This principle may be applied to most transistor oscillator circuits. If parameters of the phase-shift network are altered in such a manner as to keep the current attenuation constant at the selective frequency, then the tuned frequency may be varied. This may be achieved in the circuit described by ganging the two resistors r_1 and r_2.

The principal use to which this type of circuit could be put, is as a bridge detector. For this use, the circuit described would require additional amplifying stages. The circuit is not reliable for continuous and repeated operation with a Q factor higher than about ten since high stability and high selectivity are not compatible. It is possible, however, to operate a particular circuit with much higher selectivities of a hundred or more, but it is found that the circuit is not stable over a period of time owing to minor changes in transistor parameters.

Acknowledgments

This article forms part of a thesis accepted by London University for the degree of M.Sc.(Eng.).

The author would like to thank Dr. P. F. Soper for the use of the facilities of the Electrical Department, Northampton College of Advanced Technology, London. The author is also indebted to Dr. F. C. Widdis, who suggested the project, and gave valuable advice. The author gratefully acknowledges the receipt of a D.S.I.R. grant.

Appendix

Analysis of Input Impedance of Fig. 6

The input impedance of the circuit of Fig. 6 is found from the equivalent circuit, which is shown in Fig. 14. In order to analyse this circuit, an assumption is made that the collector load is sufficiently small that the collector may be considered to inject a current which is independent of load, that is r_o is considered infinite.

Considering the input loop of the equivalent circuit, the input impedance is found in the form:

$$Z_{in} = r_{b1} + \frac{r_{e1}}{(1-\alpha_1)} + \frac{R_2}{(1-\alpha_1)} \cdot [1 + (I_{e2}/I_{e1})]$$

$$= \frac{h_{11(1)}}{(1-\alpha_1)} + \frac{R_2}{(1-\alpha_1)} \cdot [1 + (I_{e2}/I_{e1})]$$

From the loops containing R_x, Z_1 and Z_2; and R_x, r_b, r_e, and R_2; the ratio of the emitter currents may be found as follows:

$$-(I_{e2}/I_{e1}) = \frac{[R_x + Z_1 + (\alpha_1 Z_2 R_x/R_2) + Z_2]\dfrac{R_2/R_x}{(1-\alpha_2) + \dfrac{(h_{11(2)}+R_2)}{R_x}}}{Z_1 + Z_2 + \dfrac{1}{1/R_x + \left[\dfrac{1}{(h_{11(2)}+R_2)/(1+\alpha_2)}\right]}}$$

It is necessary to make some approximations in this expression, in order to obtain it in a reasonable form.

(1) In the denominator, assume that $1/R_x$ to be much greater than $(1-\alpha_2)/(h_{11(2)}+R_2)$. This is equivalent to saying that R_x is smaller than the input resistance to the base of the second transistor.

(2) In the numerator, assume that $(1-\alpha_2)$ to be much less than $(h_{11(2)}+R_2)/R_x$. This condition is well satisfied with R_2 and R_x of the same order of magnitude.

An important simplification may be made by incorporating R_x with Z_1. This means that the resistance in Z_1 must be increased by R_x in evaluating the frequency, and attenuation constant A. With the above simplifications, the expression for the ratio of the currents becomes:

$$-(I_{e2}/I_{e1}) = \frac{R_2}{(h_{11(2)}+R_2)} + \frac{\alpha_1 R_x}{(h_{11(2)}+R_2)(A+jB)}$$

This expression can be substituted in the equation for Z_{in}.

References

1. Hooper, D. E., Jackets, A. E. Current Derived Resistance-Capacitance Oscillators Using Junction Transistors. *Electronic Engng. 28*, 333 (1956).
2. Wallace, R. L., Raisbeck, G. Duality as a Guide in Transistor Circuit Design. *Bell Syst. Tech. J. 30*, 381 (1951).

Alloy-Diffused Transistors

By E. Wolfendale*, B.Sc., A.M.I.E.E.

In this article it is shown why the conventional method of manufacturing alloy junction transistors is incapable of further exploitation at v.h.f. and the method of making the alloy-diffused transistor is given together with the reasons for its advantages.

Next, the performance of existing alloy-diffused transistors is described in a number of typical circuits. Finally, the future range of alloy-diffused transistors is discussed and it is concluded that when the range is fully established it will be possible to replace thermionic valves for most purposes with the exception of ultra high frequency work and power transmitting.

(Voir page 129 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 136)

IF the state of transistor development as it stands today is examined, an interesting parallel with the situation which existed seven years ago can be drawn. Then the low frequency small signal junction transistor had made its appearance in production quantities, and the possibilities of the transistor were established. However, the equipment designer could not realize these potentialities till the complete range of transistors—high frequency, low frequency, and power—were available. Now the same situation exists with the new v.h.f. Mesa transistors. The first mass-produced transistors have been available for some time, but the full possibilities of this new technique will not be realized till the whole range of transistors made by this technique are in mass-production.

When one reflects on this situation, three questions immediately spring to mind.

(1) Why is a new technique needed to make these transistors?

(2) What is the performance of the existing v.h.f. transistors, and what are their limitations?

(3) What will the full range of mass-produced v.h.f. transistors look like in the near future?

The Manufacturing Technique

Fig. 1 shows the equivalent circuit and the cross-sectional diagram of a high frequency alloy junction transistor. An examination of this Figure will show how the parameters which limit the performance of the transistor are related to its physical dimensions. The parameters which limit the performance of the transistor are the base resistance $r_{bb'}$, and the input capacitance $C_{b'e}$, and the feedback capacitance $C_{b'c}$.

The base resistance is the ohmic resistance of the germanium material between the emitter and collector junctions and the ring base contact. For better performance this base resistance needs to be reduced, but as it is a function of the resistivity of the germanium material which makes the transistor, to reduce it would mean the reduction of the resistivity of this material, and this reduction would result in a decrease of the allowable voltage on the transistor and an increase of two of the capacitances.

The input capacitance $C_{b'e}$ is made up of two capacitances in parallel. The first is known as the emitter depletion capacitance, that is the capacitance between the emitter and the base formed by the emitter junction. This capacitance is a direct function of the area of the emitter junction and is inversely proportional to the square root of the resistivity of the base material. The second capacitance is known as the diffusion capacitance as it is an approximate representation of the diffusion of the carriers across the base material. This capacitance is a function of the width of the base—the narrower the base the smaller the capacitance.

The other capacitance in the equivalent circuit is $C_{b'c}$, or the feedback capacitance. This capacitance is formed

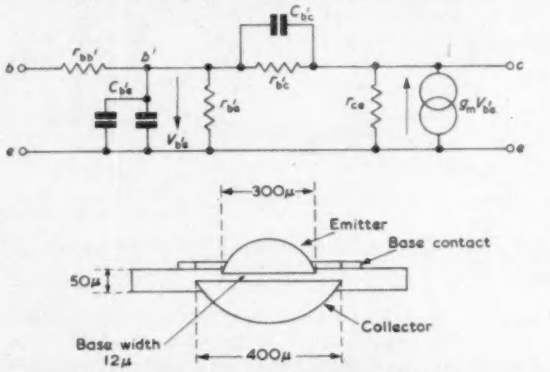


Fig. 1. The hybrid π equivalent circuit and a cross-sectional diagram of a high frequency alloy junction transistor

mainly by the collector depletion capacitance, which, like the emitter depletion capacitance, is a direct function of the area of the collector junction and is inversely proportional to the square root of the resistivity of the base material. A very small part of $C_{b'e}$ is related to the diffusion capacitance, but this is small enough to be neglected for most purposes.

To improve the performance of the transistor the values of all these capacitances need to be reduced. The emitter depletion and collector depletion capacitances can be reduced in two ways; the area of the junction can be reduced by making smaller pellets, or the resistivity of the base material can be increased. Unfortunately this latter approach would mean a higher base resistance which would adversely affect the performance of the transistor.

The diameters of the emitter and collector pellets are already down to 300 and 400μ respectively, and the difficulty of aligning and alloying smaller pellets than these makes a reduction of the emitter depletion and collector depletion capacitances by this method impracticable.

The emitter diffusion capacitance can only be reduced by decreasing the width of the base. The base width of 12μ is arrived at by alloying the two indium pellets into the 50μ slice of germanium. This base width could not be reduced much below the figure of 12μ as the control of temperature to arrive at a narrower base width is virtually impossible with existing mass-production techniques.

To overcome these difficulties in improving the alloy

* *Mullard Ltd.*

junction transistor, a new technique has been evolved using diffusion and alloying, known as the alloy-diffusion process[1]. This process gives the necessary reduction in the capacitances of the transistor.

Figs. 2, 3, 4 and 5 show the various steps in the manufacture of a transistor by the alloy-diffusion process.

The start is a slice of high resistivity p type germanium which has an n type impurity diffused into the surface. The slices are put into a chamber containing the vapour of the n type metal, in this case a vapour of antimony. The vapour diffuses slowly into the crystal, and as the diffusion is a slow process, the depth of penetration can be relatively easily controlled by regulating the time the slices are kept in the vapour. The first step provides, therefore, a slice of p type germanium with the dimensions shown in the Figure and a diffused region of n type germanium 10μ thick all around the slice.

Next, two small pellets, one of n material (n+) and the other of p material containing n material, are alloyed on to the top of the diffused slice of p type germanium. The

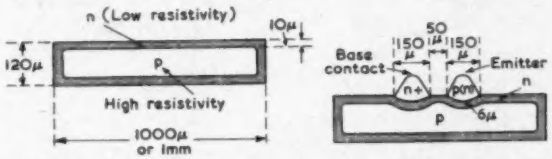


Fig. 2. (left) The 'p' type germanium slice with a diffused layer of 'n' type impurity

Fig. 3. (right) The emitter and base are alloyed on

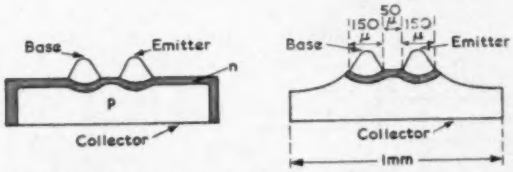


Fig. 4. (left) The collector contact is made to the p type germanium

Fig. 5. (right) The redundant n type layer is etched away

n pellet, as it alloys in, makes contact to the n layer diffused into the p type germanium. The other pellet, made up of p type material containing some n material, forms an emitter junction between the p material and the diffused n material on the top of the slice. However, as both pellets contain n material, this n material diffuses deeper into the p type slice as the pellets are alloyed, thus pushing the diffused layer in front of the alloying process. Therefore the base of the transistor, which is formed by the original diffused n type layer, proceeds in front of the alloying of the two small pellets, giving the result as shown in Fig. 3.

The bottom of the slice is now etched away to remove the n type layer, and the collector contact is soldered directly on to the p type germanium. The collector junction lies between the p type germanium and the n layer which covers the rest of the crystal. This would give far too large a value of collector capacitance. To reduce this capacitance a small area is masked off around the base and emitter contacts and the crystal is further etched to remove the rest of the n layer, giving the result as shown in Fig. 5.

The way in which the performance of the transistor is improved by this technique can now be considered.

First of all the start is a high resistivity p type slice. This means the collector junction is formed between a low resistivity n diffused layer and a high resistivity p type crystal. The value of the collector depletion capacitance is therefore reduced because of the high resistivity on the collector side. However, the base resistance has not increased because a low resistivity n type diffused layer forms the base. The emitter diffusion capacitance is reduced considerably, not only by the fact that the base width has been reduced, but also because the base is a diffused base; it contains a built-in drift field which further reduces the emitter diffusion capacitance[2]. The emitter depletion capacitance, unfortunately, is not reduced to the same extent as the collector depletion capacitance because it is formed by the capacitance between the low resistivity emitter and the low resistivity base. It is therefore only reduced by the fact that the emitter diameter has been reduced from 300 to 150μ. The dimensions so far referred to for the alloy diffused transistor are for the OC170 type transistor, and it should be remembered that this is the first of the range of alloy diffused transistors and is not typical of the limit of this technique, as are the dimensions of the high frequency alloy junction transistor mentioned earlier.

The Performance of Existing Alloy-Diffused Transistors

There are two main applications for the OC170/171, first in v.h.f. receivers and second in computing and high speed pulse applications. The performance of the transistors in these applications will be taken in that order.

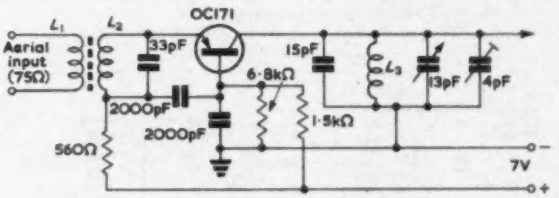


Fig. 6. F.M. receiver r.f. stage

The V.H.F. Receiver

Fig. 6 shows the r.f. stage on the f.m., v.h.f. receiver.

The main points to note about the circuit are that the transistor is used in grounded base and that it is operated with the negative line earthed. The bias is provided in the normal way by a potentiometer in the base circuit and a resistor in the emitter, by-passed by two 2 000pF capacitors. The reason for using the transistor in grounded base is that at the frequencies considered, 87 to 101Mc/s, the transistor is used in an unneutralized stage and the feedback is such that in the grounded emitter connexion it would be negative, reducing the gain, but in the grounded base stage it is positive and increases the gain. The circuit gain and phase-shift in the grounded base connexion are also such, that although the gain is increased slightly by the positive feedback, there is no possibility of instability occurring. The remainder of the circuit is quite conventional, with an aerial input transformer feeding straight into the emitter, and a tuned output circuit in the collector, with its usual trimming capacitor. The gain of the transistor in this circuit is 13dB.

Fig. 7 shows the frequency changer. Again the transistor is used in grounded base with a similar biasing network to that used in the r.f. stage. The capacitance on the input provides a series resonant circuit with the tuned circuit in the output of the r.f. stage, thus matching the r.f. output to the input of the mixer. Feedback is applied from the oscillator coil in the collector, back to the emitter via the 1 to 6pF trimming capacitor. This capacitive feedback provides the additional phase-shift required to maintain oscillation, and the amplitude of oscillation is adjusted

by trimming the capacitor. To maintain good stability, the collector is tapped into the oscillator coil to provide the least damping on the tuned circuit. The inductor, L_4, and the 330pF capacitor in the emitter are resonant at the i.f. frequency and thus provide a low impedance path for the i.f. component coming from the mixing. The output is fed to the first i.f. transformer. The conversion gain in this circuit is 15dB.

The i.f. stage shown in Fig. 8 again has a similar biasing network; it needs no neutralization because the feedback capacitance is low enough combined with the gain required that the circuit is clear of instability. The circuit shows capacitive tapping from the tuned i.f. transformers but inductive tapping could equally well be used. The stage gain is limited by the feedback capacitance of the transistor to 20dB.

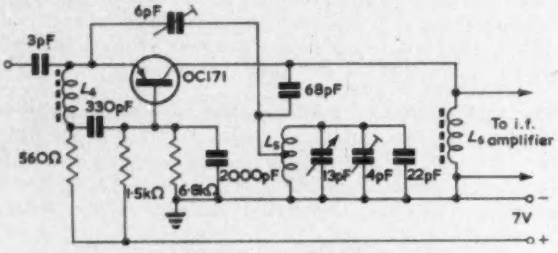


Fig. 7. F.M. receiver frequency-changer
frequency range 87 to 101Mc/s
gain 15dB

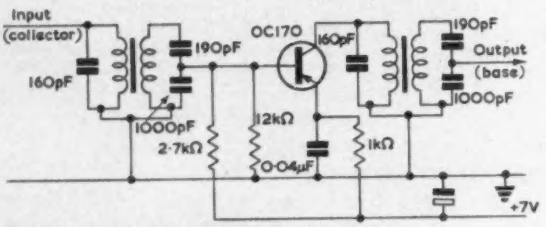


Fig. 8. 10·7Mc/s i.f. stage

Computing and High Speed Pulse Applications

For high speed pulse work the transistor must not be allowed to bottom, because the hole storage in the bottomed condition is high, in fact almost as high as the normal alloy transistors, and this hole storage would considerably reduce the speed of operation. The technique which is used to overcome this difficulty is known as current switching, and is shown in Fig. 9.

First assume that the transistor is off. The current defined by $+V_{cc}$ and R will therefore flow through the diode to ground. The transistor is now switched on by the negative going pulse applied to the base. The emitter is held by the diode at earth potential, and so the whole of the pulse appears across the base emitter junction, thus switching the transistor on fast. As the transistor comes on, the defined current is diverted from the diode into the transistor, the whole of the input pulse being available to charge the transistor input capacitance until all the current is diverted. Then a current defined by the negative excursion on the base plus the voltage V_{cc} across the resistor R supplies a defined current through the transistor into the collector. The value of the load resistance in the collector is chosen such that under these conditions the transistor is clear of the bottomed region. When the transistor is switched off the reverse process takes place and the current is diverted back into the diode.

The use of this current switch may be illustrated in two applications. The first is a fast linear time-base shown in Fig. 10.

As can be readily seen, the transistor is operating in a current switch mode. A current of 15mA defined by the +24V, the catching voltage of +12V on the diode, and the 750Ω resistor in the emitter, flows into the diode when the transistor is off. The transistor is held off by the +12·5V level on its base. In this condition the 5mA in the collector defined by the 50kΩ resistance and the −250V supply, flows into the AAZ13 diode to ground; the OA10 diode is held off by the +5V. The capacitor is therefore initially discharged.

When the input level on the base changes from +12·5 to +11, the transistor is switched on by the current switch technique and the 15mA is diverted from the diode into

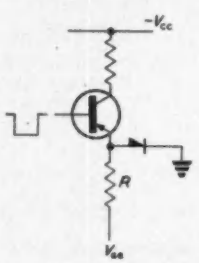


Fig. 9. Current switching

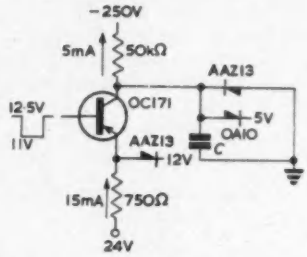


Fig. 10. A fast linear sweep generator

the transistor. 5mA of the collector current will continue to flow in the 50kΩ collector load, the remaining 10mA charges the capacitor and the collector moves positively cutting off the AAZ13 diode. The positive voltage on the capacitor increases until it is caught by the OA10 to the +5V line. As a defined current is flowing into the capacitor, this produces a linear sweep voltage across the capacitor. When the transistor is switched off, the 5mA discharges the capacitor to the −250V line until the AAZ13 diode again conducts and the capacitor is held discharged at earth potential. The −250V gives a fast recovery of the charge from the capacitor.

The second application is an illustration of the use of the current switch circuit together with diode logic for computing, and is shown in Fig. 11.

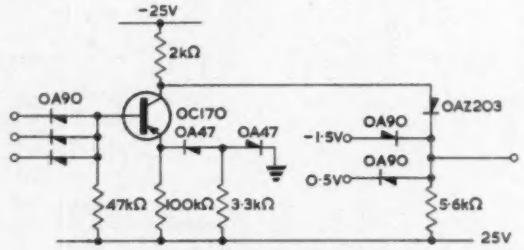


Fig. 11. Diode logic and the current switch

Again the emitter current is defined by the +25V and the 3·3kΩ emitter resistor; for the moment the effect of the additional diode and the 100kΩ resistor will be neglected. The defined current initially flows through the diode to ground until an input appears through the diode gates shown on the left. This input will switch the transistor on and divert the current from the diode into the collector. The resultant output voltage is translated from the 2kΩ collector load by the Zener diode and the two catching

diodes to levels which will operate the next current switch. The propagation time in this circuit is 25mμsec.

The reason for the additional diode is that for high speed operation it is necessary to keep the voltage swing requirement to a minimum, as any extra voltage swing has to charge the stray capacitances and therefore slows down the operation. When the transistor is off, the defined emitter current flows through the diode to ground. There is, however, an additional defined current formed by the +25V and the 100kΩ resistor. This current cannot flow through the diode to ground as the other diode is preventing it. This very small current must therefore flow through the transistor. This means that the transistor is never fully

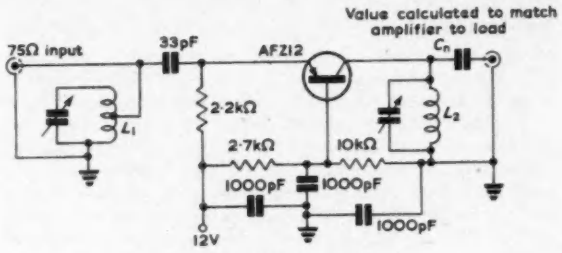


Fig. 12. 200Mc/s amplifier

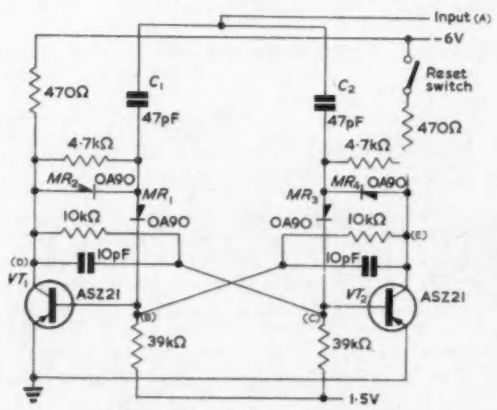


Fig. 13. A 10Mc/s binary counter

switched off, but is always kept in the conducting direction and no extra voltage is required to charge and discharge the emitter depletion capacitance.

The Future Range of V.H.F. Transistors

The transistors just described are the forerunners of a whole range of mass-produced v.h.f. transistors made by the alloy-diffused technique. The improvements can be divided into the following categories:

(a) Higher frequency performance.

(b) Higher speed switching.

(c) Higher power handling capabilities.

(d) Adaptations to make special devices.

(a) Higher Frequency Performance

The AFZ12 transistor shown in Fig. 12 is a higher frequency version of the OC171 and will give adequate amplification at 200Mc/s. The design of the 200Mc/s amplifier is, of course, very similar to that of the r.f. amplifier for the v.h.f. receiver. The gain in the circuit is 10dB.

(b) Higher Speed Switching

For higher speed switching it is useful to have a transistor which will bottom, as this will not only give higher speed switching in the current switch type circuit, but may also be used in a bottomed condition for more conventional circuits. An example of this is shown in Fig. 13 where two ASZ21 transistors are connected in a normal bottoming type Eccles-Jordan circuit. The diodes MR_1 and MR_3 associated with the 4·7kΩ resistors provide the necessary gating to give binary division from the single input of positive pulses.

For example, when VT_1 is on and bottomed and VT_2 is off, MR_1 is slightly forward biased by the negative voltage

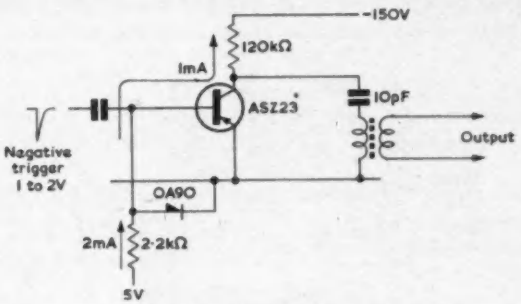


Fig. 14. The avalanche pulse generator

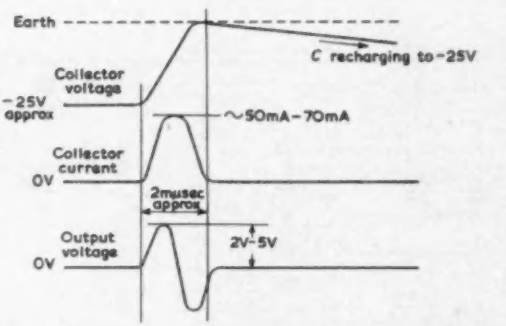


Fig. 15. The voltage and current waveforms of the avalanche pulse generator

on the base of VT_1 while MR_3 is reverse biased by the negative voltage at the collector of VT_2. The next positive pulse is therefore passed by MR_1, thus switching off VT_1. The diodes MR_2 and MR_4 ensure complete recovery of the charge on the capacitors C_1 and C_2 before the next trigger pulse. The circuit is capable of reliable operation at a 10Mc/s repetition rate.

For very high speed pulse work the alloy diffusion process can be used to make an avalanche transistor. Initially avalanche transistors were selected from the high frequency alloy transistors, but the new technique enables such a transistor to be made in its own right.

The circuit shown in Fig. 14 demonstrates the performance of such a transistor.

The transistor is normally held off by a negative bias applied to its base. The supply voltage is much greater than the avalanche voltage of the transistor, and the circuit is so arranged that about 1mA flows between base and collector, thus setting the transistor on its avalanche characteristic. A further 1mA from the +5V line flows through a catching diode, thus fixing the positive potential on the base as the forward voltage across the diode. A negative

trigger pulse is applied to the base, switching the transistor on. Avalanche multiplication occurs in the collector depletion layer, giving a current gain greater than one, and the capacitor of 10pF between collector and ground is rapidly discharged through the transistor. The discharge of the capacitor continues due to the hole storage in the transistor until almost zero voltage is reached when the transistor switches off, the capacitor then recovers through the 120kΩ load resistor charging towards the −150V line till it is caught by the avalanche characteristic of the transistor.

Fig. 15 shows the waveforms achieved in the circuit. The collector voltage falls from −25V to ground in approximately 2mμsec, giving a pulse of current in the emitter with a peak of 50 to 70mA. This current is passed through

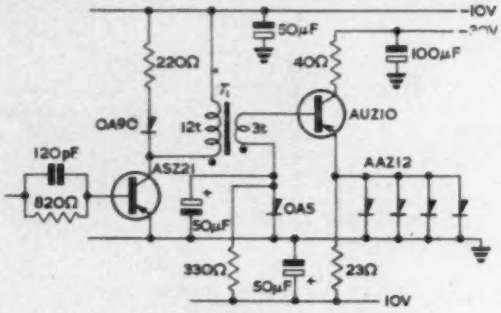


Fig. 16. A fast high current pulse generator

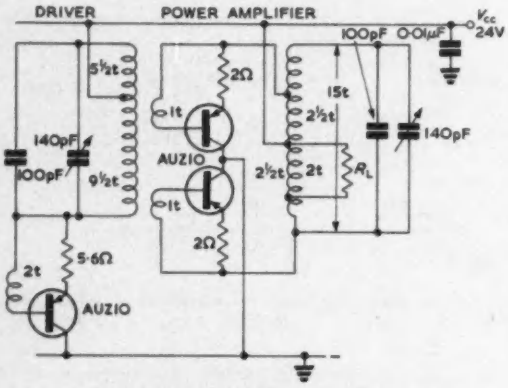


Fig. 17. An 8Mc/s power amplifier

the differentiating output transformer and gives a positive output pulse of 1mμsec duration and 2·5V amplitude.

(c) Higher Power Handling Capabilities

The alloy diffused technique also lends itself readily to the manufacture of high frequency power transistors. Such a power transistor can be used both for producing fast high current pulses for high speed storage in computers and also for low power medium frequency transmitters.

Fig. 16 shows a high frequency power transistor providing a ½A pulse with a rise-time of 20mμsec and a fall time of 40mμsec. As the transistor would be slowed up by bottoming it is used as a current switch, with a current in the emitter normally passing through the diodes to ground defined by the 33Ω resistor. The transistor is switched by a transformer from the driver transistor and is normally held off by the positive voltage across the OA5 diode in series with the drive winding.

The driving transistor gives another illustration of the use of the high speed bottoming transistor ASZ21. The output stage requires a defined voltage drive on its base. This is provided by bottoming the driver transistor so that, taking the transformer ratio into account, a 2·5V pulse defined by the supply voltage of 10V is applied to the AUZ10. The OA90 diode in series with the 220Ω resistor damps the overswing on the drive transformer when the driver transistor is switched off.

The transmitter output stage shown in Fig. 17 uses three power transistors, one as the driver and the other two in class-B push-pull output. The circuit design follows normal practice with a tuned driver transformer and the small resistors in the emitters of the output transistors to improve their frequency performance in the circuit. The output transformer is a normal tuned transformer. The transistors

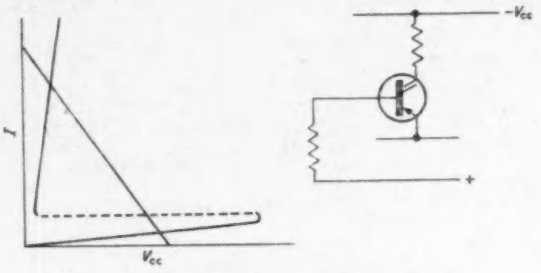


Fig. 18. The pnpn switch

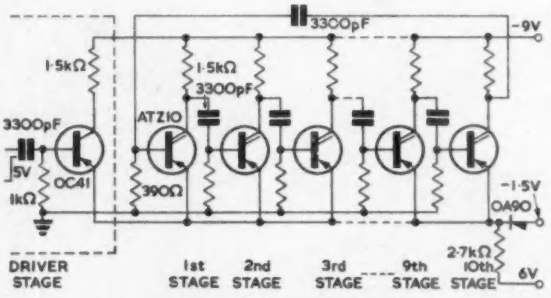


Fig. 19. A decade ring counter circuit using ATZ10 pnpn transistors

deliver 2½W in the output at 8Mc/s, and the overall power gain of the driver and the output stage is about 23.

(d) Adaptation to Make Special Devices

The alloy diffused technique may be also used to make a pnpn switch of the type shown in Fig. 18.

The operation of this transistor is best explained by considering the I_cV_c characteristics. The transistor is normally held off, and as the collector voltage is increased, only a very small leakage current flows. This leakage current increases as the voltage is raised, until the leakage current flowing through the resistor in the base circuit reduces the base voltage to zero and brings the transistor into conduction. When this happens, because it is a pnpn structure, the current gain between emitter and collector is greater than unity and the transistor is in an unstable region and promptly switches to its bottomed conditon as determined by the load in the collector. The device may thus be regarded as a switch which is either off or bottomed, and in fact behaves in a similar manner to the cold-cathode trigger tube. The device may be turned off by reducing the collector or emitter current to zero.

An application of these transistors is shown in Fig. 19, where a decade ring counter is made up of 10 transistors.

The emitters of the transistors are commoned and the emitter current is defined by the +6V line and the catching diode to −1·5V. This defined current can flow in any of the transistors, but as the transistors have to be either bottomed or cut-off, and the collector loads are arranged such that for the transistor to be bottomed it must take all of the defined emitter current, only one of the ring can be on at any one time.

The transistors are all connected in one loop by the capacitors between the collector of the preceding transistor and the base of the succeeding transistor. The operation of the ring is performed by the normal type transistor connected in parallel with the remainder of the transistors. When this transistor is switched on it diverts all the emitter current from the ring, thus ensuring that all the ring are off. The pnpn transistor which was originally on, passes a pulse via the capacitor to the base of the next pnpn transistor, thus priming it so that when the input pulse vanishes and the parallel transistor goes off, the emitter current is diverted into the primed transistor. Therefore for each successive pulse, the on transistor progresses round the ring. The speed of operation of such a counter using the ATZ10 transistors may be as high as 30kc/s.

Conclusions

This new range of alloy diffused transistors, together with the ones which will follow, open up new possibilities for instrumentation, computing, and portable equipment, as well as giving the possibility of replacing most of the remaining thermionic valves except those used for very high frequency work and for power transmitting.

Acknowledgments

In this article the results of the efforts of a large number of engineers at The Mullard Southampton Works have been presented, and in particular the author would like to acknowledge the assistance of his colleagues in the Development and Application Laboratories, about whose work he has written. He would also like to thank the Directors of Mullard Limited for permission to publish this article.

REFERENCES

1. Beale, J. R. A. Alloy Diffusion: A Process for Making Diffused Base Junction Transistors. *Proc. Phys. Soc., Lond. 70*, 1087 (1957).
2. te Winkel, J. Drift Transistor. *Electronic Radio Engr. 36*, 280 (1959).

BIBLIOGRAPHY

Yourke, H. S. Millimicrosecond Transistor Current Switching Circuits. *I.R.E. Trans. CT-4*, 236 (1957).
Beale, J. R. A., Stephenson, W. L., Wolfendale, E. A Study of High Speed Avalanche Transistors *Proc. Instn. Elect. Engrs. 104B*, 394 (1957).
Santilli, R. A., Thanos, H. Portable Radio Uses Drift Field Transistors. *Electronics. 33*, 48 (July 1960).

Speed Control for Television Camera Attitude*

Servo operated television cameras, controlled by means of a shot box are rapidly becoming a valuable addition to television studio equipment for interviews, reporting, announcements, etc. In the shot box, attitudes of pan and tilt and settings of iris, focus or zoom are established as voltages on preset potentiometers, the outputs of which are switched into the relevant servo comparator circuit by the appropriate shot button. A disadvantage of the present method of comparing the voltage from the potentiometer coupled to camera pan or tilt movement with that from the shot setting potentiometer, is that the camera tends to swing rapidly from one shot to the next because of the gain of the servo loop, and the resulting visual effect often causes unpleasant sensations in the audience. Various forms of mechanical damping can be applied, but these are costly and inflexible.

A new method of limiting the velocity of swing of a television camera is now proposed, see Fig. 1, in which the differential error voltage input to the servo is limited by means of a pair of semiconductor diodes MR_1 and MR_2, having suitable forward threshold voltage characteristics, as in Fig. 2. These diodes are connected in parallel, but mutually reversed, across the error input terminals of the servo. To the limited error voltage is added in reverse polarity, according to the normal servo practice, an adjustable part of the output of the servo tachometer generator. Thus when the velocity of the servo becomes such that the voltage tapped from the tachogenerator output equals the threshold limited error voltage, the velocity of traverse will remain constant and this velocity may be readily adjusted by varying the fraction of the total tachometer output used. The velocity will be maintained until the error voltage falls below the diode threshold in the vicinity of the new position setting. This system thus provides a considerable improvement in the operation of a servo controlled camera by means of a shot box or indeed of any similar type of servo control and with no degradation of the servo sensitivity in the region of the balance position.

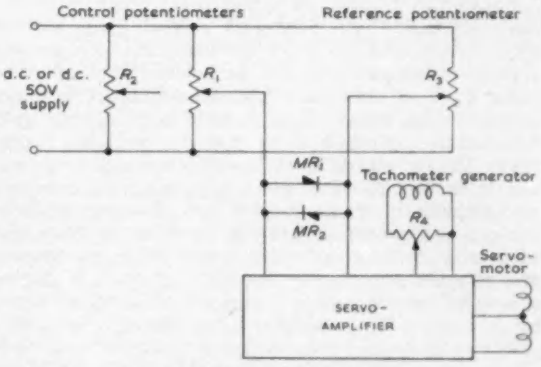


Fig. 1. Basic circuit arrangement

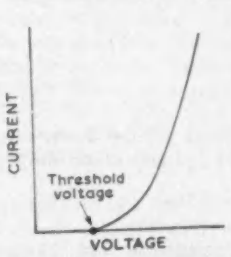


Fig. 2. Diode characteristics

* *A communication from E.M.I. Ltd.*

trigger pulse is applied to the base, switching the transistor on. Avalanche multiplication occurs in the collector depletion layer, giving a current gain greater than one, and the capacitor of 10pF between collector and ground is rapidly discharged through the transistor. The discharge of the capacitor continues due to the hole storage in the transistor until almost zero voltage is reached when the transistor switches off, the capacitor then recovers through the 120kΩ load resistor charging towards the −150V line till it is caught by the avalanche characteristic of the transistor.

Fig. 15 shows the waveforms achieved in the circuit. The collector voltage falls from −25V to ground in approximately 2mμsec, giving a pulse of current in the emitter with a peak of 50 to 70mA. This current is passed through

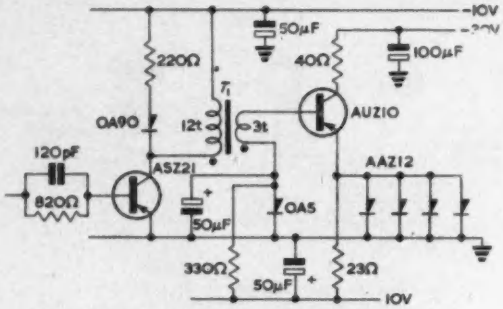


Fig. 16. A fast high current pulse generator

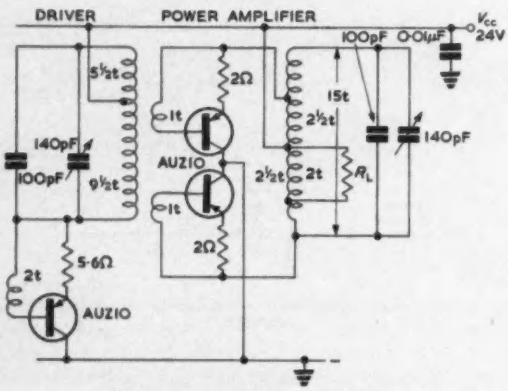


Fig. 17. An 8Mc/s power amplifier

the differentiating output transformer and gives a positive output pulse of 1mμsec duration and 2·5V amplitude.

(c) Higher Power Handling Capabilities

The alloy diffused technique also lends itself readily to the manufacture of high frequency power transistors. Such a power transistor can be used both for producing fast high current pulses for high speed storage in computers and also for low power medium frequency transmitters.

Fig. 16 shows a high frequency power transistor providing a ½A pulse with a rise-time of 20mμsec and a fall time of 40mμsec. As the transistor would be slowed up by bottoming it is used as a current switch, with a current in the emitter normally passing through the diodes to ground defined by the 33Ω resistor. The transistor is switched by a transformer from the driver transistor and is normally held off by the positive voltage across the OA5 diode in series with the drive winding.

The driving transistor gives another illustration of the use of the high speed bottoming transistor ASZ21. The output stage requires a defined voltage drive on its base. This is provided by bottoming the driver transistor so that, taking the transformer ratio into account, a 2·5V pulse defined by the supply voltage of 10V is applied to the AUZ10. The OA90 diode in series with the 220Ω resistor damps the overswing on the drive transformer when the driver transistor is switched off.

The transmitter output stage shown in Fig. 17 uses three power transistors, one as the driver and the other two in class-B push-pull output. The circuit design follows normal practice with a tuned driver transformer and the small resistors in the emitters of the output transistors to improve their frequency performance in the circuit. The output transformer is a normal tuned transformer. The transistors

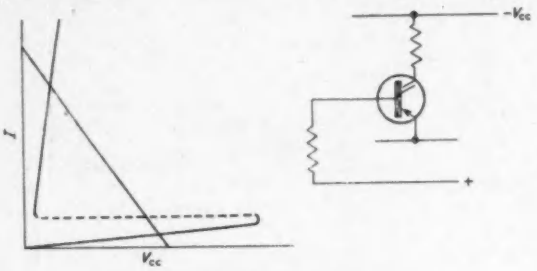


Fig. 18. The pnpn switch

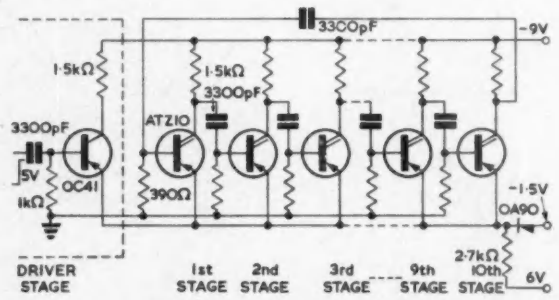


Fig. 19. A decade ring counter circuit using ATZ10 pnpn transistors

deliver 2½W in the output at 8Mc/s, and the overall power gain of the driver and the output stage is about 23.

(d) Adaptation to Make Special Devices

The alloy diffused technique may be also used to make a pnpn switch of the type shown in Fig. 18.

The operation of this transistor is best explained by considering the I_cV_c characteristics. The transistor is normally held off, and as the collector voltage is increased, only a very small leakage current flows. This leakage current increases as the voltage is raised, until the leakage current flowing through the resistor in the base circuit reduces the base voltage to zero and brings the transistor into conduction. When this happens, because it is a pnpn structure, the current gain between emitter and collector is greater than unity and the transistor is in an unstable region and promptly switches to its bottomed conditon as determined by the load in the collector. The device may thus be regarded as a switch which is either off or bottomed, and in fact behaves in a similar manner to the cold-cathode trigger tube. The device may be turned off by reducing the collector or emitter current to zero.

An application of these transistors is shown in Fig. 19, where a decade ring counter is made up of 10 transistors.

The emitters of the transistors are commoned and the emitter current is defined by the +6V line and the catching diode to −1·5V. This defined current can flow in any of the transistors, but as the transistors have to be either bottomed or cut-off, and the collector loads are arranged such that for the transistor to be bottomed it must take all of the defined emitter current, only one of the ring can be on at any one time.

The transistors are all connected in one loop by the capacitors between the collector of the preceding transistor and the base of the succeeding transistor. The operation of the ring is performed by the normal type transistor connected in parallel with the remainder of the transistors. When this transistor is switched on it diverts all the emitter current from the ring, thus ensuring that all the ring are off. The pnpn transistor which was originally on, passes a pulse via the capacitor to the base of the next pnpn transistor, thus priming it so that when the input pulse vanishes and the parallel transistor goes off, the emitter current is diverted into the primed transistor. Therefore for each successive pulse, the on transistor progresses round the ring. The speed of operation of such a counter using the ATZ10 transistors may be as high as 30kc/s.

Conclusions

This new range of alloy diffused transistors, together with the ones which will follow, open up new possibilities for instrumentation, computing, and portable equipment, as well as giving the possibility of replacing most of the remaining thermionic valves except those used for very high frequency work and for power transmitting.

Acknowledgments

In this article the results of the efforts of a large number of engineers at The Mullard Southampton Works have been presented, and in particular the author would like to acknowledge the assistance of his colleagues in the Development and Application Laboratories, about whose work he has written. He would also like to thank the Directors of Mullard Limited for permission to publish this article.

REFERENCES

1. Beale, J. R. A. Alloy Diffusion: A Process for Making Diffused Base Junction Transistors. *Proc. Phys. Soc., Lond. 70*, 1087 (1957).
2. te Winkel, J. Drift Transistor. *Electronic Radio Engr. 36*, 280 (1959).

BIBLIOGRAPHY

Yourke, H. S. Millimicrosecond Transistor Current Switching Circuits. *I.R.E. Trans. CT-4*, 236 (1957).
Beale, J. R. A., Stephenson, W. L., Wolfendale, E. A Study of High Speed Avalanche Transistors *Proc. Instn. Elect. Engrs. 104B*, 394 (1957).
Santilli, R. A., Thanos, H. Portable Radio Uses Drift Field Transistors. *Electronics. 33*, 48 (July 1960).

Speed Control for Television Camera Attitude*

Servo operated television cameras, controlled by means of a shot box are rapidly becoming a valuable addition to television studio equipment for interviews, reporting, announcements, etc. In the shot box, attitudes of pan and tilt and settings of iris, focus or zoom are established as voltages on preset potentiometers, the outputs of which are switched into the relevant servo comparator circuit by the appropriate shot button. A disadvantage of the present method of comparing the voltage from the potentiometer coupled to camera pan or tilt movement with that from the shot setting potentiometer, is that the camera tends to swing rapidly from one shot to the next because of the gain of the servo loop, and the resulting visual effect often causes unpleasant sensations in the audience. Various forms of mechanical damping can be applied, but these are costly and inflexible.

A new method of limiting the velocity of swing of a television camera is now proposed, see Fig. 1, in which the differential error voltage input to the servo is limited by means of a pair of semiconductor diodes MR_1 and MR_2, having suitable forward threshold voltage characteristics, as in Fig. 2. These diodes are connected in parallel, but mutually reversed, across the error input terminals of the servo. To the limited error voltage is added in reverse polarity, according to the normal servo practice, an adjustable part of the output of the servo tachometer generator. Thus when the velocity of the servo becomes such that the voltage tapped from the tachogenerator output equals the threshold limited error voltage, the velocity of traverse will remain constant and this velocity may be readily adjusted by varying the fraction of the total tachometer output used. The velocity will be maintained until the error voltage falls below the diode threshold in the vicinity of the new position setting. This system thus provides a considerable improvement in the operation of a servo controlled camera by means of a shot box or indeed of any similar type of servo control and with no degradation of the servo sensitivity in the region of the balance position.

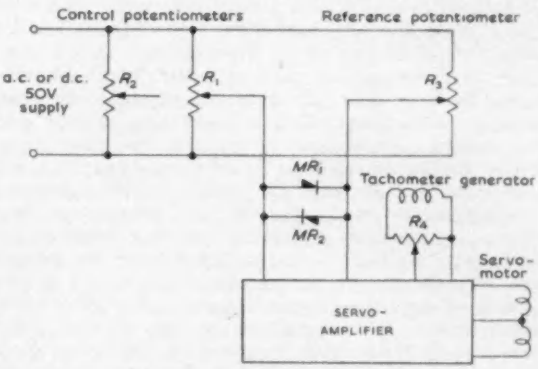


Fig. 1. Basic circuit arrangement

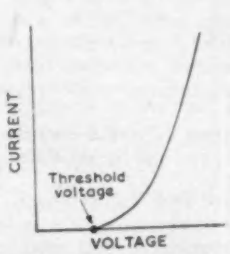


Fig. 2. Diode characteristics

* *A communication from E.M.I. Ltd.*

Fluidized Beds as Constant Temperature Enclosures

By H. Sutcliffe*, M.A., A.M.I.E.E.

The problem of maintaining electronic components at a constant known temperature for the purpose of measuring characteristics is discussed. The fluidized bed technique, in which the constant temperature enclosure is a bed of solid particles floated on an up-current of air, is an alternative to existing methods. The construction and performance of a small fluidized bed is described and the conclusion is reached that the fluidized bed method has many advantages.

(Voir page 129 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 136)

THE characteristics of most electronic components depend on temperature, and a large amount of effort in laboratories and in the inspection departments of factories is spent in measuring and recording the characteristics of components as functions of temperature. These measurements are particularly important for semiconductor devices. Various methods of surrounding a component by a medium of known temperature are in use, but a survey of these existing methods shows that none is entirely satisfactory. The component may, for instance, be placed in a stream of hot air, but it is difficult to control the temperature of the air and almost impossible to produce an arrangement which is not unpleasantly noisy. An oven with a good thermostat and with forced circulation of air provides very accurate control of temperature, but is rather inconvenient because the oven door has to be opened each time a new component is tested. Liquid baths also provide good temperature control and components may be inserted freely, but the liquids must be electrically non-conducting and those liquids which are readily available are either inflammable or toxic. Further, the dripping of liquid from a component makes the handling problem very awkward. Another method of establishing the temperature of a component, the 'hot plate' method, is to place it in good thermal contact with a mass of metal of known temperature. This method can be very effective, but is restricted to devices such as power transistors and diodes whose construction is such that they are already provided with surfaces for making a good thermal contact.

The fluidized bed technique, in which a bed of solid particles is floated on an up-current of air and is well stirred in the process, offers an alternative method of providing a constant temperature environment for component testing[1,2,3,4].

A brief description of the construction and performance of a fluidized bed and its ancillary apparatus follows.

A Typical Fluidized Bed

Mechanical Construction

Preliminary experiments and trials showed that no aspect of the design was critical, and the detailed mechanical design of the complete equipment was determined only by practical considerations such as the availability of material and the convenience of the user. The particular models which were constructed were designed so as to be no larger than was necessary to test small components such as low-power transistors and diodes, and the isothermal nature of fluidized beds is so excellent that half an inch clearance round components of this size is adequate. The principal internal diameter need be no greater than 1¼in, and a compact design as shown schematically in Fig. 1 was found to be quite satisfactory. The top plate (*a*) is necessary because when a component is removed from the bed there will be a small pile of particles on its top horizontal surface. These are normally poured back into the bed by tilting the component and the top plate is provided in case any should go astray. Particles which accumulate on the top plate can be brushed back into the bed.

* *University of Bristol.*

Particle Size and Air Flow

Large particles require a greater flow of air than small, so a bed which contained particles varying greatly in size would be in danger of having either the larger particles in a non-fluidized state at the bottom, or the finer particles blown away at the top. Some control over the uniformity of particle size is required and the author's opinion is that a diameter ratio of two to one should not be exceeded. Fine particles require less air, but large particles cause less trouble when they are accidentally spilt, and an optimum size is perhaps in the region of ·005in in diameter. Sand, graded by suitable sieves, is quite satisfactory, and glass 'beads' or 'ballotini' which are available commercially as almost perfect spheres, are ideal.

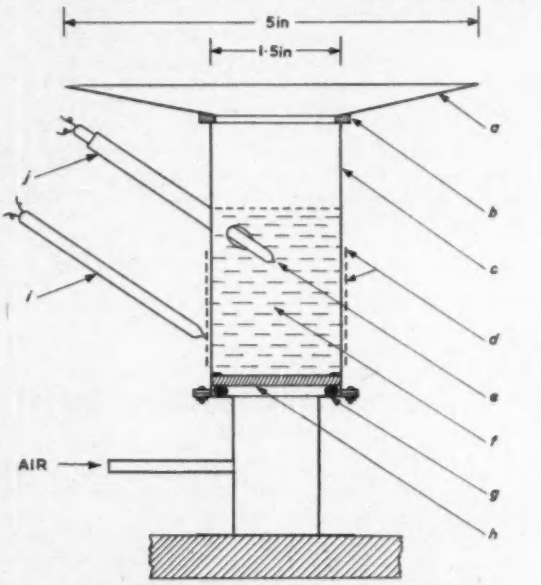


Fig. 1. Schematic cross-section of small fluidized bed

a, top plate; *b*, felt ring; *c*, thin-walled brass tube, 1·5in i.d., 3in long, stove enamelled on outer surface; *d*, tape heating element, clamped to tube *c* by asbestos pad; *e*, bead thermistor Th_1. Tip is 0·2in from inner surface of tube *c*; *f*, bed of solid particles 2in deep when not fluidized; *g*, silicone rubber O ring air seal; *h*, porous bronze disk, 1·5in diameter, ¼in thick; *i*, thermistor Th_2; *j*, brass tube ¼in o.d. brazed to tube *c*. Centre line offset so that thermistor Th_1 lies well clear of centre of bed.

The air flow required is determined in practice by watching the bed as the rate of flow of air is increased. The particles lie inertly at first, then float without relative motion, then boil and bubble with an obvious swirling action up the centre and down the sides. The ideal rate of flow is that which just produces the swirling activity and is most easily maintained from a constant current supply of air since the pressure drop through the bed is that of the head of the column of particles and is almost constant. When several beds are supplied from the same

air supply the most convenient arrangement is to have a constant pressure valve, which maintains a pressure of say 2lb/in² above atmospheric, followed by individual adjustable control valves which offer a high impedance to the air flow to their associated beds. The figure of 2lb/in² is not at all critical, but is mentioned because it is adequately large compared with the pressure drop in a typical bed yet small enough to allow the use of light plastic tubing for the air connexions. A typical measurement of the flow of air which gave a suitable degree of turbulance to the bed was three cubic feet per hour per square inch of bed surface.

Temperature Control

A fluidized bed can be heated either by elements immersed in the bed or by elements around the outside of the tube which contains the bed. The second method is more appropriate when the bed is used for testing electronic components, because the metal tube shields the component from the electromagnetic field of the heating

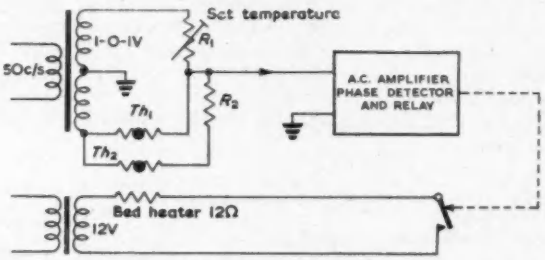


Fig. 2. Temperature control circuit

Thermistors Th_1, Th_2, type F15, 70kΩ at 30°C 10kΩ at 70°C
R_1, 100kΩ maximum
R_2, approximately $20R_1$

element. The heating element shown in Fig. 1 is a length of nichrome tape with a resistance of 12Ω wound directly on the stove-enamel surface of the tube. The peak heating power is 12W, which is ample to maintain a bed temperature of 100°C. Several methods of temperature control were tried, the most satisfactory being a thermistor bridge circuit shown in outline in Fig. 2. Thermistor Th_1 is the main control element, and in the absence of the circuit comprising thermistor Th_2 and R_2 the bridge becomes balanced and the relay contacts open as the resistance of Th_1 falls with increasing temperature to a value equal to R_1. Cyclic fluctuations in temperature then take place about a mean temperature which is determined by R_1. The purpose of the additional circuit Th_2 in series with R_2 is to reduce the amplitude of the cyclic fluctuations by increasing the frequency of switching. R_2 is greatly in excess of R_1 and the mean temperature of the bed is dependent on the temperature of Th_2 to only a small extent.

Performance of a Typical Fluidized Bed

The statements in this section apply to a bed of the shape and size shown in Fig. 1, the bed material being sand particles which had been sieved between B.S.S. meshes Nos. 72 and 170.

Practicability

The convenience and practicability of the method were tested by making a bank of three such beds side by side and setting the temperatures to 30°, 50° and 70°C. The bank was used to obtain measurements of the characteristics of small junction diodes and transistors over this range of temperature. No difficulty was encountered in obtaining reproducible results, and the convenience and cleanliness of the method was found to be greatly superior to previous experiments in which baths of transformer oil were used.

Isothermal Region

It is to be expected that the bed is hottest in regions near the heated walls and coolest near the porous plate where cold air is entering. A series of measurements with an exploring thermojunction showed that these effects are not normally significant. When the bed was at a temperature 50°C above ambient, for instance, the temperature variation was less than 0·1°C within the region enclosed by a surface 0·2in from the walls and 0·5in from the porous plate.

Heat Transfer Rate

Northwood[2] gives extensive data on the heat transfer rates between fluid beds and spherical solids immersed therein, and it can be deduced from his results that a typical figure for the heat transfer coefficient is 0·03 Centigrade heat units per second per square foot per °C, which is equivalent to 0·06W/cm²/°C. The author's own measurements have been much less comprehensive, but are in approximate agreement. The following example shows the order of magnitude of the heating rate which can be expected. A solid copper cylinder, ¼in diameter and ¼in long, was suddenly immersed and its temperature measured as a function of time. The temperature of the cylinder approached the temperature of the bed exponentially, the time-constant being 13sec. The corresponding figure for the time-constant of heat transfer from the cylinder by radiation and convection in still air was twenty times greater. The implication of the high rate of heat transfer obtainable is that small components can be tested quickly, since their external surfaces and lead wires assume the temperature of the bed within a second or so after immersion.

Electrical Conductivity

The bed particles themselves are non-conducting, and leakage between the leads of a component under test takes place by physical transfer of charged particles. The leakage currents, fortunately, are very small, being of the order of 10^{-9}A for a p.d. of 200V between electrodes 1cm square with 0·5cm spacing. This leakage current is not normally significant but in the rare situation when it is excessive the bed can be made truly non-conducting for the period of measurement of the component characteristics by turning off the air supply.

Conclusion

Fluidized beds have advantageous features when used for testing electronic components. They are compact and clean, and the stirring of the particles by the fluidizing air ensures that temperature control is accurate and that heat transfer is rapid.

A practical disadvantage is that the components to be tested should be dry and free from grease to prevent the adherence of bed particles.

Acknowledgments

The author is grateful to Mr. G. F. C. Rogers, of the Department of Mechanical Engineering of Bristol University, for suggesting the use of fluidized beds for component testing, and to Mr. E. Glenny of the National Gas Turbine Establishment for much useful practical advice.

References

1. Shaw, S. W. K. A Review of the Literature on Heat Transfer in Fluidised Beds. National Gas Turbine Establishment, Note No. NT. 184 (Dec. 1955).
2. Northwood, J. E. Experimental Heat Transfer Data for Beds of Fluidised Solids. National Gas Turbine Establishment, Note No. NT. 185 (Dec. 1955).
3. Glenny, E., *et al.* A Technique for Thermal-Shock and Thermal-Fatigue Testing Based on the Use of Fluidized Solids. *J. Inst. Metals.* **87**, 294 (1959).
4. Slin'ko, M. G. Application of a Pseudo-Fluid Bed for Heating and Cooling in Laboratory Investigations. *J. Phys. Chem. (Moscow)*, **32**, 2841 (1958).

A Multi-Purpose Computer Element

By C. B. Taylor*, B.Sc.

The element described is essentially a long-tailed pair waveform reshaper which, together with a number of logical gates, can have many uses as a basic element for a computing system. The main design aim was to produce an economical binary counter stage employing transistor diode logic, but among the many other possible uses of the element are a pulse generator, simple reshaper, delay with reshaped biphase outputs bistable element, and free running square wave generator.

(Voir page 129 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 136)

THE principle of the bistable reshaper is demonstrated by Fig. 1. The circle labelled with an R represents a reshaping circuit which is designed to take a slice out of an input waveform applied at I, and produce from it two outputs R_1 and R_0 having standard voltage levels, and good rise- and fall-times. It is in fact a squaring circuit. The output R_1 is in phase with the input signal, and R_0 is in antiphase with it.

Consider that the input T_1 to the two input OR-gate is at '0', the input T_2 to the two input AND-gate is at '1' and the output R_0 is at '0'. Under these conditions both gates will be closed and the reshaper input I will be at '0'. This is consistent with the reshaper output R_1 being at '0', so the condition is stable.

If now the input T_1 goes to '1', then I will follow and consequently so will the output R_1, thus completing the loop via the two input AND-gate and OR-gate and maintaining the input I at '1'. T_1 can be returned to '0' and the circuit will retain this new state. Further if now T_2 goes to '0' the two input AND-gate will close and the '0' so produced will propagate round the loop back to the other input to the two input AND-gate. T_2 can be returned to '1' and the circuit will retain this state. The arrangement is in fact a 'bistable element' or 'one bit store'.

The main disadvantage of this type of bistable reshaper is that it requires a trigger going from '0' to '1' to set it to the '1' state, and a trigger from '1' to '0' to reset it to the '0' state. Fig. 2 shows a second arrangement which does not have this disadvantage. Here the reshaper has a second input I_+ which, if at '1', will completely over-ride the input I and cause the output R_1 to be at '0'. When I_+ is at '0' the outputs are determined by I as before.

Consider initially that both trigger inputs T_1 and T_2, and the reshaper output are all at '0', then I will be '0' and the circuit is stable. As before if T_1 goes to '1', the output R_1 goes to '1', thus holding I at '1', and the conditions are again stable in this new state. T_1 can then be returned to '0' and the circuit will retain this new state. In a similar way it can be reset by applying a trigger to the input T_2, thus causing R_1 and hence I to return to '0'. If both triggers are applied simultaneously then the circuit will take up the state where R_1 is '0' and R_0 is '1', and if they are removed at the same instant this state will be the final state. The arrangement of Fig. 2 is, then, a bistable element with both triggers obeying positive logic.

Application to Binary Counters

The 'series' method of connecting a number of bistable elements together to form a counter, where the first stage only is triggered and its output then causes the next stage to turn over and so on, suffers from the disadvantage for high speed working of cumulative delay. The last stage turns over after all the other stages have done so and at a time after the initial trigger that is dependent in an additive way on the delay between input and output of all the preceding stages. In high speed computing systems this delay becomes serious and 'parallel' triggering connexions in which all stages are turned over at the same time, but which require more equipment become necessary.

A standard method of connecting a series of bistable elements to form a binary counter with parallel triggering is shown in Fig. 3. Here the circles labelled with a B represent the bistable elements, and these are such that the arrowed outputs produce a '1' when the arrowed inputs are triggered, and similarly for the unarrowed inputs and outputs.

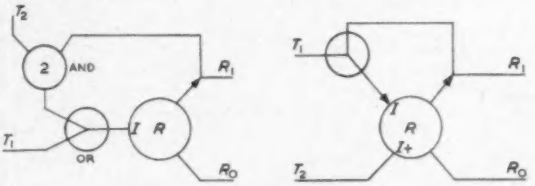


Fig. 1. (left) Simple bistable reshaper
Fig. 2. (right) Bistable reshaper with both triggers having the same polarity

The boxes labelled shift and emitter-follower are to compensate for the voltage shift produced by the 2-gates of the carry line and to provide current gain. It will be seen that two delays are necessary per stage whose value must be greater than τ the width of the trigger line pulse. Also π the period of the maximum trigger rate must be greater than the delay value, or:

$$\tau < \Delta < \pi$$

To achieve reliable operation and high counting rate, these delays must have a good bandwidth and cannot be simple RC integrating networks. These delays, then, form quite a large fraction of the extra equipment involved in connecting normal bistable elements together in this way to produce a counter.

If the bistable element of Fig. 1 is used, only one delay is necessary per stage due to the inverse logic of the reset trigger. Unfortunately, however, it becomes necessary to propagate both the carry and its complement; and two trigger lines, also complementary, are required. So what is gained on the delay is lost in extra gating and wiring complication.

The best of both worlds can be achieved if the bistable element of Fig .2 is used. A single delay, carry line and trigger line only are needed as can be seen from an examination of Fig. 4.

A shift register and consequently a ring counter can be made using the arrangement shown in Fig. 5. It will be noticed that, due to the over-riding nature of the reshaper input I_+, single wire transfer is possible between stages. This is a further useful advantage of this type of bistable

* *E.M.I. Electronics Ltd.*

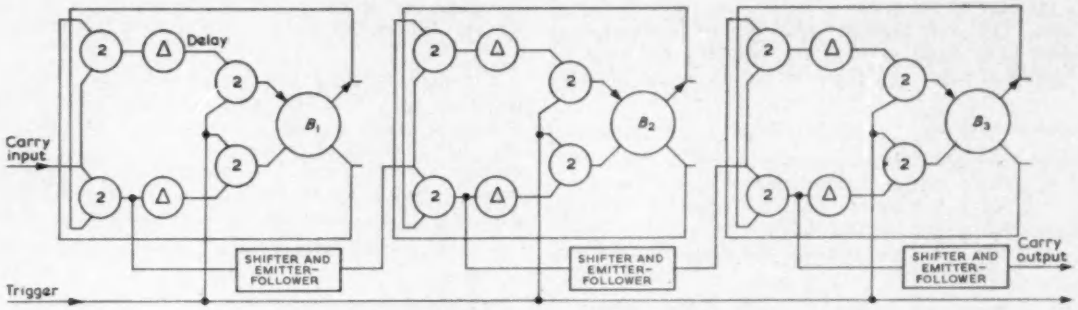


Fig. 3. A standard form of binary counter with parallel triggering

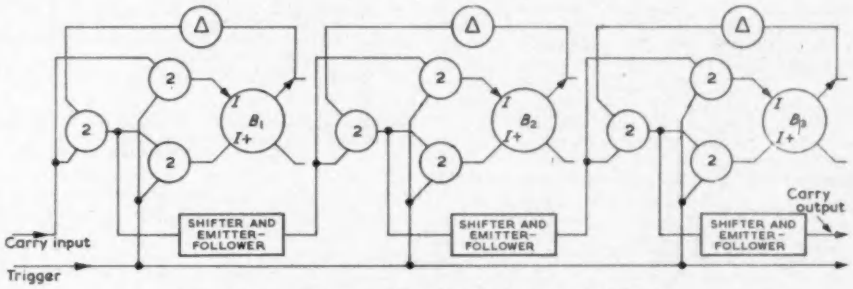


Fig. 4. Binary counter employing the bistable element of Fig. 2

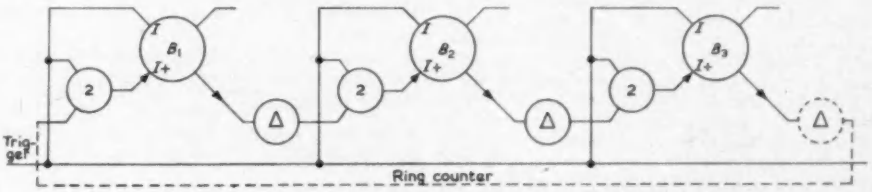


Fig. 5. A shift register employing the bistable element of Fig. 2

element; single wire transfer can be obtained without the usual time wasting process of clearing the receiving element. first.

Other Applications of this Type of Reshaper

Square Wave Generator

Consider the configuration shown in Fig. 6. If I is taken to '1' then R_1 goes to '1' and after a delay Δ so does I_+. This returns R_1 to '0' and after a delay Δ, I_+ follows and so on. The circuit is in fact a square wave generator so long as the input I remains at '1'. The cycle time can be varied by simply altering the delay.

Pulse Regenerator

A further application of the arrangement of Fig. 6 is as a pulse regenerator. In this case the dotted line and OR-gate are also required. If a pulse sufficiently wide to complete the hold on loop is applied at I then the output R_1 will show a '1' for a time Δ after which the bistable element will be reset. The maximum input pulse width must be less than 2Δ. The circuit will then produce standard width full amplitude pulses from pulses which have deteriorated.

Pulse Generator

The arrangement of Fig. 7 will produce pulses of width Δ coincident with a rising edge applied at the input A. For example, if a square wave is presented at A, the output will be a pulse train of the same period as the square wave, each pulse having width Δ.

Exlcusive 'or' or Non-equivalent Circuit

Fig. 8 shows the method of connexion to generate the logical function:

$$(C + D) \cdot \overline{(C \cdot D)},$$

the exclusive OR-gate. The inverse function, equivalence of the two inputs is generated at the other output of the reshaper, and both outputs are at standard levels and have good rise-time.

By means of a configuration such as shown in Fig. 9, most of the circuits already discussed, and more, are realizable in a single element. A single basic element of this type could satisfy a large portion of the circuit needs of a computing system. The Table 1 gives the input conditions required to produce the various types of logical element.

In the case of the exclusive OR-gate the delay Δ should be zero. The shift register needs further elaboration as follows: The input to V is the output carry, C_{out}, of the previous stage, and therefore a '0' in the previous

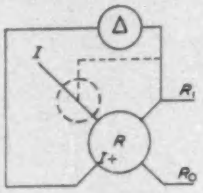


Fig. 6. Square wave generator

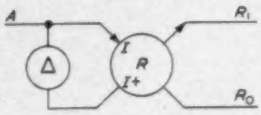


Fig. 7. Pulse generator

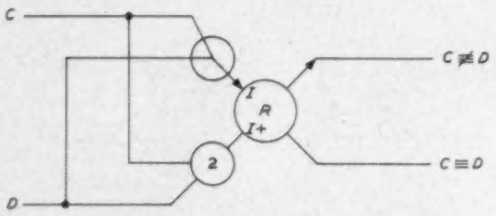


Fig. 8. Exclusive 'OR' or 'not equivalent' circuit

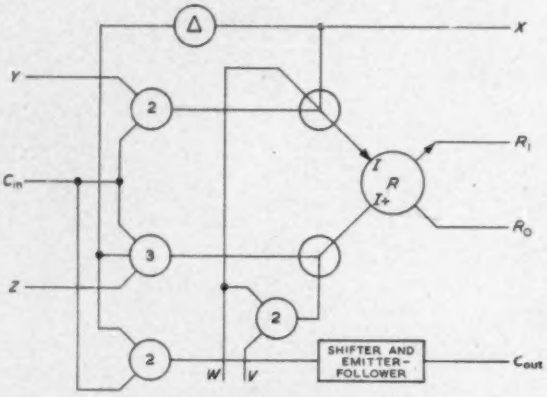


Fig. 9. Multi-purpose computer element

stage will be shifted in as a '1' to the present stage and vice versa. In a shift register this can easily be overcome by interchanging the outputs R_1 and R_0, in name and logical meaning, on alternate stages while leaving the circuits identical. In other words, on odd stages the '1' output would be defined as that which produces a '1' when I is triggered, and on even stages that which produces a '1' when I_+ is triggered. It follows then that a ring counter must have an even number of stages; although

TABLE 1

TYPE	V	W	X	Y	Z	C_{in}
Counter stage ..	0	0	R_1	Trig	Trig	Carry Input
Pulse generator ..	0	0	Input	0	1	1
Pulse regenerator	0	0	R_1	Input	1	1
Square wave generator ..	0	0	R_1	1	1	1
Reshaper ..	0	0	0	Input	0	1
Delay and reshaper	0	0	Input	1	1	1
Exclusive OR-gate	0	0	C Input	1	1	D Input
Shift register stage	Input	Trig	R_1	0	0	1

of course the extra stage, which may result, need not be a storage element, but could be one of these circuits used as an invertor.

The inputs V and W can also be used to enter data into a counter with W as the trigger pulse input. Here again it should be mentioned that, if the counter is to count 'up', the input V must show a '1' to enter a '0' into the counter, and vice versa. The inverse is true if the counter counts 'down', the direction of counting being dependent only on the definition of the two outputs R_1 and R_0.

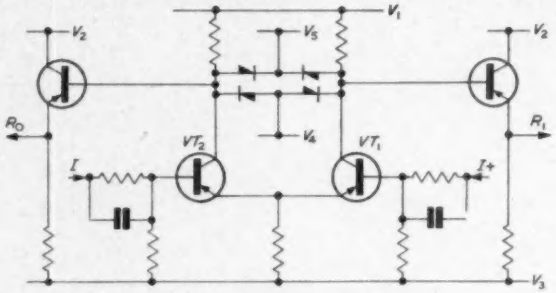


Fig. 10. Circuit diagram of the reshaper

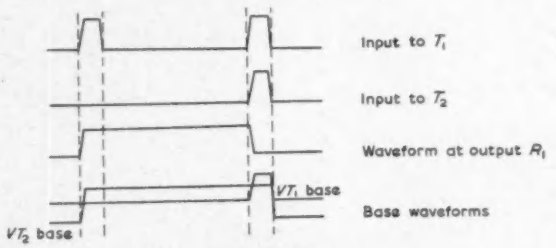


Fig. 11. The circuit waveforms

Circuit Discussion

The basic reshaper used in this type of logical element, has been the two transistor long-tailed pair shown in Fig. 10.

The collectors of the reshaper are caught to provide standard level outputs; and the logic has been defined such that a '1' is represented by a collector being caught at the positive voltage V_5, and a '0' if caught at the more negative voltage V_4. The collectors are provided with emitter-follower output stages.

The I and I_+ inputs are those to the potential dividers on the bases of the reshaper transistors. These potential dividers are such that if a standard '0' level is applied at I_+, then the voltage at the base of VT_1 lies midway between the voltages at the base of the VT_2 when the input I is at standard '0' level and at standard '1' level; and then if a standard '1' level is applied at I the voltage at the base of VT_2 lies approximately midway between the voltages at the base of VT_1 when the input I_+ is at standard '0' level and standard '1' level. It follows that the output R_1 will be at '0' if either I_+ is at '1' or I is at '0'.

Normal diode gates have been used for the AND and OR-gate; and the OR-gate and delay lines have been provided with emitter-follower output stages.

The waveforms, Fig. 11, illustrate what occurs when a circuit of the type shown in Fig. 2 is used and first a single pulse is applied to T_2 and then a pulse applied to both T_1 and T_2 simultaneously.

The delay lines used were of small dimensions giving

delays of the order of 25mμsec/in. Using OC170 transistors and OA90 diodes, counters have been assembled which operate satisfactorily with counting speeds in excess of 10Mc/s. With 2N501 transistors in the reshaper of the fastest stage counting speeds of up to 25Mc/s have been obtained. Five stage counters have been constructed, but from an examination of the output carry from the last stage there seems to be no reason why more stages should not be added. The counters have been triggered from another of these elements connected as a pulse generator giving an output pulse width of approximately 25mμsec. With these circuits rise-times and delays of between 10 and 15mμsec are obtainable. Many of the other modes of operation of these circuits, described earlier, have also been tried successfully.

Conclusion

The type of logical element described appears to have many useful applications in the computer field. It is not suggested that the arrangement described is the best. Indeed the best arrangement will no doubt vary between one field of application and the next.

Artificial Stimulation of the Heart

Methods of artificial stimulation of the ventricle in a patient suffering from low cardiac output due to complete heart block have been attracting the attention of the medical world for some time past.

With low cardiac output, the pulse rate falls to a low rate of the order of 22 to 30 pulses a minute when the circulation is inadequate.

The rate of beat of the pumping chamber of the heart (the ventricle) is normally under the control of the upper chamber (the auricle), itself under nervous control. If the electrical connexion between auricle and ventricle is broken, the condition is known as heart block. In this circumstance the ventricle beats at a slow fixed rate.

It has been possible to provide an effective external electrical connexion by means of flexible leads attached to the heart muscle, and brought through the chest wall to a suitable pulse generator external to the patient. Such a generator is called an artificial cardiac pacemaker. However, this is generally unsatisfactory surgically since the outlet points are liable to infection.

In Sweden, one solution to the problem has been found in the construction of a miniature electronic pulse generator, complete with a sealed secondary cell, which can be inserted into the chest wall of a patient requiring this type of treatment. Battery charging is effected every few days, by inductive coupling with an external pulse unit, via a built-in rectifier system. In this arrangement, a high degree of reliability for all components is required.

A similar cardiac pacemaker is being developed in America by the School of Medicine at the University of Maryland, Baltimore together with the Westinghouse Electric Corporation. This unit is operated entirely by transistors and both the rate and amplitude of the pulse can be regulated to suit the individual patient. The pulse generator is external to the patient and connexions from the heart muscle are brought to the chest wall. It is intended for use only in hospitals or as an emergency arrangement.

An additional unit called a Cardiac Monitor has been designed for use in conjunction with the pacemaker. It indicates the heart rate on a dial and automatically sets off an alarm signal if the pulse deviates or stops. It also incorporates a radio transmitter with a radius of 2½ miles to broadcast an alarm signal to a receiver carried by a doctor.

In England a successful system has been designed at the Queen Elizabeth Hospital, Birmingham, using the principle of induced e.m.f. in a coil containing a ferrous dust core mounted in the chest wall, the flexible leads of the coil being attached and electrically connected to the heart muscle.

One of the problems associated with this method is the impregnation and sealing of the internally positioned coil and its leads to prevent ingress of body fluids to the copper wire forming the winding. At the same time, the coil is subject to a small lateral movement during the patient's normal activity. Both conditions have been satisfactorily overcome by the nylon impregnation of the coil windings, and the addition of stainless steel braided outlet wires in sealed nylon tube.

The equipment external to the patient comprises an electronic pulse generator, an induction coil and a small re-chargeable accumulator. The electronic unit is a self-excited oscillator having a pulse repetition frequency controllable from 30 to 100 pulses per minute. A small Lucas transistor is used in the first stage of the unit to actuate a relay and determine the time duration of the final output current pulse. The value of the latter is approximately 6A of 2msec period in the 1Ω output coil.

The impregnation of the patient's external induction coil is less critical, and can be encapsulated in a dental resin or silicone rubber in order to give non-irritant contact with the skin. Plastic covered flexible copper wire has been used successfully to connect this coil unit to the electronic generator.

The position of the coil, relative to the internally mounted unit, is somewhat critical in order to ensure an adequate magnetic coupling, and it is normally held in place by an adhesive strip. Recent tests with a higher permeability iron have reduced the necessary accuracy for coil position thus enabling the patient to place it more easily.

The original coils which were constructed by the Queen Elizabeth Hospital and mounted in the chest wall, were wound with copper wire with silver electrode terminations and fully impregnated with nylon. The outlet wires were of braided stainless steel wire, on to which nylon tube was fused by electrically heating the wire.

Subsequent developments introduced by Joseph Lucas Ltd, Birmingham, have resulted in a satisfactory impregnation in polytetrafluorethylene for both coil and leads.

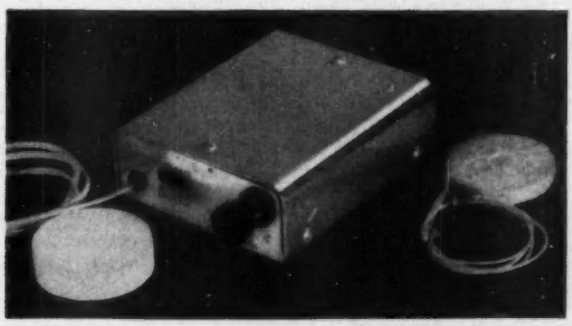
The original electronic circuit made use of an electromagnetic relay to switch the output transistor, the Lucas circuit has been developed on a purely electronic basis, to eliminate any moving parts and is constructed on a printed circuit board of small dimensions.

In each coil, the ferrous core has been selected for high permeability in order to eliminate the necessity for accurate positioning of the two units. The induced e.m.f. remains substantially constant for lateral movement in the external coil of 1¼in.

The external energizing coil is now fitted with a smaller gauge of flex lead containing silver plate conductors and will be exteremely durable, although reduced considerably in weight.

The transistor configuration has been changed to npn silicon and the Lucas DT11 unit is used in the modified design.

The stimulator unit with the external and internal coils



A Variable Bandwidth Band-Pass Filter

By J. Holland, B.Sc.(Eng.)

A method is described whereby several bandwidths may be obtained in an LC filter employing one set of inductors only. The design of a typical filter with an actual plot of its attenuation characteristic is included.

(Voir page 129 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 136)

IN communication engineering, it is sometimes desirable to have a filter unit, which would be small and compact, yet having the facility of bandwidth adjustment. A series of fixed bandwidth filters would give the required result by switching in the appropriate filter, but this would, of necessity, be bulky. A method, which is described below, has been devised which gives excellent results and yet employs only the same number of inductors as that required by a fixed bandwidth filter. By a straightforward switching arrangement, bandwidth changes as high as 8:1 have been obtained.

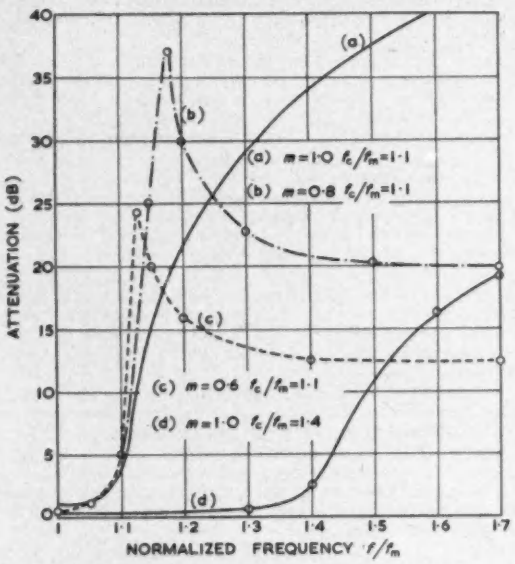


Fig. 1. Individual band-pass filter characteristics (*m sections*) *Plotted assuming* $Q = 100$

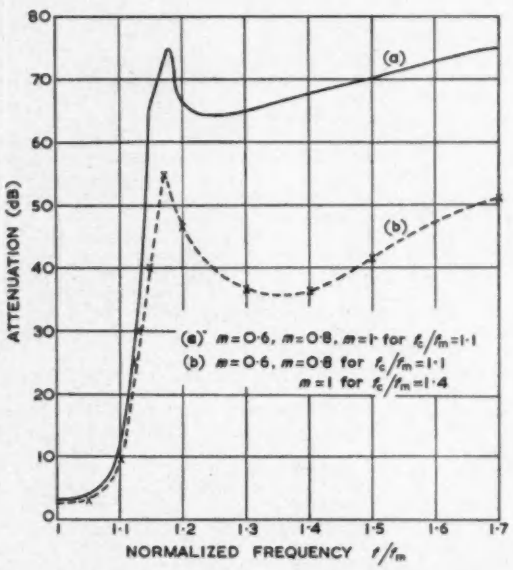


Fig. 2. Attenuation characteristics of composite band-pass filter

Theory

For most practical purposes in filter design, satisfactory characteristics can be obtained by combinations of m type filter sections having values of m equal to 1, 0·8 and 0·6. The $m = 1$ (constant k) section prohibits the transmission of frequencies remote from the pass-band, while the $m = 0{\cdot}6$ sections ensure sharp cut-off characteristics with good matching properties between the filter and the external impedances. The $m = 0{\cdot}8$ section is employed to attenuate frequencies outside the pass-band where the combined effect of the constant k and $m = 0{\cdot}6$ section is low. Fig. 1 shows the attenuation curves of the individual sections of a typical filter having coil Q values of 100, while Fig. 2(a) shows the combined characteristics. The cut-off frequency, for the example, was taken as 1·1 × centre frequency f_m.

Now, suppose a constant k section, having $f_c/f_m = 1{\cdot}4$ is used in conjunction with m sections having $f_c/f_m = 1{\cdot}1$, the resultant characteristic is given as curve (*b*) Fig. 2.

The basic section elements, for this type of filter, are shown in Figs. 3 and 4.

The practical values of all the elements are obtained from the formulae quoted below.

$$L_{1k} = \frac{R}{\pi(f_2 - f_1)} \quad \ldots\ldots\ldots\ldots (1)$$

$$C_{1k} = \frac{f_2 - f_1}{4\pi f_1 f_2 R} \quad \ldots\ldots\ldots\ldots (2)$$

$$L_{2k} = \frac{(f_2 - f_1)R}{4\pi f_1 f_2} \quad \ldots\ldots\ldots\ldots (3)$$

SYMBOLS

f_m	=	Centre frequency of pass-band
f_c	=	Cut-off frequency
f_{∞}	=	Frequency of maximum attenuation
f_2	=	Upper cut-off frequency
f_1	=	Lower cut-off frequency
$f_2 - f_1$	=	Bandwidth
R	=	Nominal pass-band impedance
y	=	Ratio of bandwidth change
x	=	Constant k transform ratio

$$C_{2k} = \frac{1}{\pi(f_2 - f_1)R} \quad \ldots\ldots\ldots\ldots (4)$$

$$L_1 = mL_{1k} \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$C_1 = C_{1k}/m \quad \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

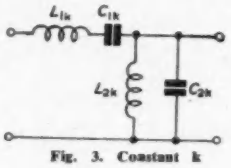


Fig. 3. Constant k

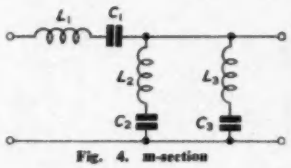


Fig. 4. m-section

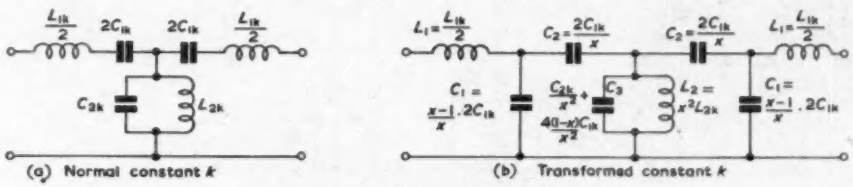


Fig. 5. Constant k transformer
x = transformation ratio

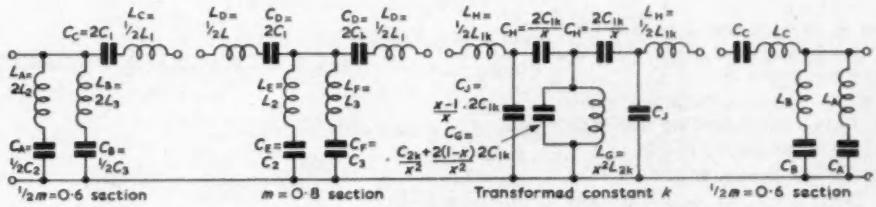


Fig. 6. Individual sections

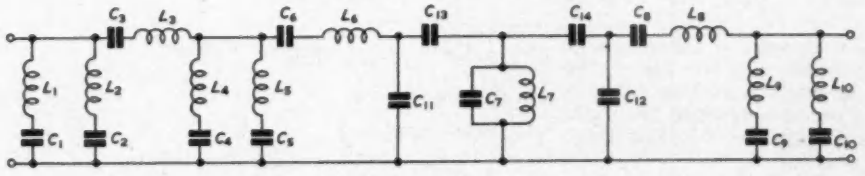


Fig. 7. Composite sections

$$L_2 = L_{1k}\left(\frac{1 - m^2}{4m}\right)(1 + [f_m/f_\infty]^2) \quad \ldots\ldots\ldots (7)$$

$$C_2 = \left[\frac{C_{1k}}{1 + (f_\infty/f_m)^2}\right]\left(\frac{4m}{1 - m^2}\right) \quad \ldots\ldots\ldots (8)$$

$$L_3 = L_{1k}\left(\frac{1 - m^2}{4m}\right)[1 + (f_\infty/f_m)^2] \quad \ldots\ldots\ldots (9)$$

$$C_3 = \left[\frac{C_{1k}}{1 + (f_m/f_\infty)^2}\right]\left(\frac{4m}{1 - m^2}\right) \quad \ldots\ldots\ldots (10)$$

Examination of the above formulae shows that all the elements of the m section are derived from the series elements of the constant k section L_{1k} and C_{1k}. Further, if the bandwidth is small compared with the centre frequency, then the product $f_1 \times f_2$ remains reasonably constant and hence, if the bandwidth $(f_2 - f_1)$ is altered by a factor y, say, and the nominal impedance R is altered by the same factor, then the values of L_{1k} and C_{1k} remain unchanged. Consequently, by suitable adjustment of the filter nominal impedance, the series element of the constant k section can be kept constant irrespective of bandwidth. Under these circumstances, therefore, the only factor which controls the values of all the elements of the m sections is the ratio f_∞/f_m. To illustrate the magnitude of variation in the values of the elements with change in bandwidth, consider a filter, having a centre frequency of 3kc/s and a maximum bandwidth of 800c/s reducing to a minimum bandwidth of 200c/s. Under these circumstances $f_2/f_m = 1{\cdot}13$ and $1{\cdot}03$ respectively, which results in values of f_∞/f_m of $1{\cdot}14$ and $1{\cdot}06$ respectively for an $m = 0{\cdot}8$ section.[1] Hence, the ratio of L_2, say, required for the widest bandwidth to that required for the narrowest bandwidth is $\frac{1 + (1/1{\cdot}14)^2}{1 + (1/1{\cdot}06)^2} = 1{\cdot}01/1{\cdot}07$, ie. a change of 7 per cent.

Similarly, the ratio of L_3 required for the narrowest bandwidth to that required for the widest bandwidth is $\frac{1 + (1/1{\cdot}14)^2}{1 + (1/1{\cdot}06)^2} = 1{\cdot}084$, i.e. a change of 8·4 per cent.

Consequently, the change in inductance is extremely small and, therefore, any loss in performance, resulting from the use of a fixed inductor, will also be small.

Also, by controlling the filter nominal impedance, as above, the series elements L_1 and C_1 of the m sections remain constant irrespective of bandwidth (equations (5) and (6)). The remaining elements, to be considered, are L_{2k} and C_{2k}, the shunt elements of the constant k section. Referring to equations (3) and (4), it will be evident that, if the bandwidth and impedance are both varied by a factor y, then L_{2k} varies by a factor y^2 and C_{2k} varies by a factor $1/y^2$. In most practical cases, the actual values of L_{2k} and C_{2k} are usually found to be rather impracticable and use is made of the impedance transformer shown in Fig. 5.

By making use of the constant k impedance transformer the inductance of the shunt inductor L_{2k} can be kept constant by suitable adjustment of the transformation ratio x.

Thus, taking all these properties into account, it will be evident that, by adjustment of the filter impedance to suit the bandwidth, a filter, having adjustable bandwidth, can be constructed using fixed valued inductors and switched capacitors and which will have attenuation characteristics closely resembling those of a set of ideal filters.

Since the shunt elements of all the m sections are operating in a series mode, it is convenient to switch the capacitors at the earthy side (Fig. 8) resulting in a minimum of coupling between sections at the switch.

In practice, it was found that the change in source and load impedances made very little difference to the attenuation characteristics compared with those obtained by using a fixed impedance.

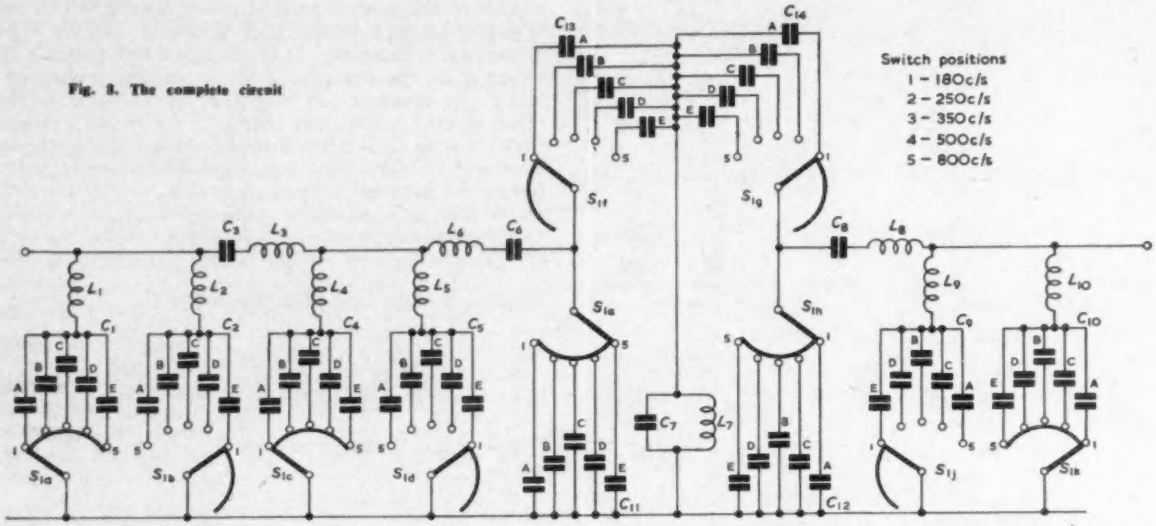


Fig. 8. The complete circuit

To design a practical filter, the procedure would be as follows.

(1) Calculate the elements of the constant k section for the widest bandwidth using equations (1) to (4) and having a fixed nominal impedance R.

(2) Calculate the elements of the m sections for each bandwidth separately (using the values of the constant k sections) from the equations (5) to (8).

Note—The values of $f_{2\infty}$ are chosen either

(a) To give peak attenuations at specified frequencies, or,

(b) to give the peaks of an ideal filter according to Smith[1].

(3) Calculate the transform elements of the constant k section using the expressions shown in Fig. 5. The transform is chosen to give a reasonable LC ratio of L_{2k} and C_{2k} at the widest bandwidth. The transform constant is then modified, for each bandwidth, to give the same inductance.

(4) Calculate the values of all the elements of the composite filter for each bandwidth separately.

(5) Calculate the resonant frequencies of each inductor-capacitor pair for each bandwidth. (E.g. L_1 and C_1 or L_2 and C_2 etc.)

(6) Choose the mean or best value of inductance for each section from the individual values.

(7) Recalculate the required capacitor values to give the same resonant frequencies as in (5) above, using the modified inductor values, for each bandwidth.

It is usually more convenient to set out all the values in tabular form.

Application

Suppose it is required to design a switched band-pass filter having the following requirements:

Nominal impedance	2 000Ω
Bandwidths (3dB points)	180c/s
	250c/s
	350c/s
	500c/s
	800c/s
Centre frequency	4kc/s
Maximum attenuation at	$f_m \pm (f_2 - f_1)$

CONSTANT k SECTION (Fig. 3)

Using equations (1) to (4) where $R = 2000\Omega$, $(f_2 - f_1) = 800$c/s $f_1 = 3600$c/s, $f_2 = 4400$c/s.

Then $L_{1k} = 2000/800\pi = 796$mH

$$C_{1k} = \frac{800}{4\pi\ 3600 \times 4400 \times 2000} = 2020\text{pF}$$

$$L_{2k} = \frac{800 \times 2000}{4\pi\ 3600 \times 4400} = 8{\cdot}04\text{mH}$$

$$C_{2k} = \frac{1}{\pi\ 800 \times 2000} = 199000\text{pF}$$

m SECTIONS (Fig. 4)

(a) *800c/s Bandwidth*

$f_{2\infty} = 4800$c/s, $(f_m/f_{2\infty})^2 = 1{\cdot}44$, $(f_m/f_{2\infty})^2 = 0{\cdot}7$

Then from equations (5) to (10):

$m = 0{\cdot}6$ section

$L_1 = 0{\cdot}6 \times 796$	$= 478$mH
$C_1 = 2020/0{\cdot}6$	$= 3370$pF
$L_2 = 796 \times (0{\cdot}6/2{\cdot}4) \times 1{\cdot}7$	$= 361$mH
$C_2 = (2020/2{\cdot}44) \times (2{\cdot}4/0{\cdot}64)$	$= 3100$pF
$L_3 = 796 \times (0{\cdot}64/2{\cdot}4) \times 2{\cdot}44$	$= 519$mH
$C_3 = (2020/1{\cdot}7) \times (2{\cdot}4/0{\cdot}64)$	$= 4450$pF

$m = 0{\cdot}8$ section

$L_1 = 0{\cdot}8 \times 796$	$= 637$mH
$C_1 = 2020/0{\cdot}8$	$= 2530$pF
$L_2 = 796 \times (0{\cdot}36/3{\cdot}2) \times 1{\cdot}7$	$= 152$mH
$C_2 = (2020/2{\cdot}44) \times (3{\cdot}2/0{\cdot}36)$	$= 7370$pF
$L_3 = 796 \times (0{\cdot}36/3{\cdot}2) \times 2{\cdot}44$	$= 218$mH
$C_3 = (2020/1{\cdot}7) \times (3{\cdot}2/0{\cdot}36)$	$= 10560$pF

(b) *Other Bandwidths*

The other bandwidths are calculated in a similar manner using the values of $f_{2\infty}$ etc., in Table 1.

TABLE 1

BANDWIDTH (c/s)	f_2	$\left(\frac{f_{2\infty}}{f_m}\right)^2$	$\left(\frac{f_m}{f_{2\infty}}\right)^2$
800	4800	1·44	0·7
500	4500	1·26	0·79
350	4350	1·18	0·85
250	4250	1·12	0·89
180	4180	1·09	0·915

TABLE 2
Element Values of Constant K Transformer Section

BAND-WIDTH (c/s)	TRANS-FORM RATIO x	L_1 (mH)	L_2 (mH)	C_1 (pF)	C_2 (pF)	C_3 (pF)
800	5	398	201	3230	810	6660
500	8	398	201	3530	504	7065
350	11·4	398	201	3690	354	7304
250	16	398	201	3790	252	7476
180	22·2	398	201	3860	182	7602

TABLE 3
Element Values
(Inductors in mH, Capacitors in pF)

BANDWIDTH (c/s)	L_A	C_A	L_B	C_E	L_C	C_C	L_D	C_D	L_H	C_E	L_F	C_F	L_G	C_G	L_H	C_H	C_J
800	722	1550	1038	2225	239	6740	318	5060	152	7370	218	10560	201	6660	398	810	3230
500	762	1675	960	2110	239	6740	318	5060	160	7970	202	10000	201	7065	398	504	3530
350	786	1735	228	2045	239	6740	318	5060	165	8260	195	9700	201	7304	398	354	3690
250	804	1785	900	2000	239	6740	318	5060	169	8500	189·5	9500	201	7476	398	252	3790
150	812	1810	880	1975	239	6740	318	5060	171·5	8600	186·5	9380	201	7602	398	182	3860

TABLE 4
Composite Values
(Inductors in mH, Capacitors in pF)

BANDWIDTH (c/s)	$L_1 = L_A$	$C_1 = C_A$	$L_2 = L_B$	$C_3 = C_B$	$L_5 = L_C+L_D$	$C_5 = \frac{C_C \cdot C_D}{C_C+C_D}$	$L_4 = L_E$	$C_4 = C_E$	$L_5 = L_F$	$C_5 = C_F$	$L_6 = L_D+L_H$	$C_6 = C_D$	$L_7 = L_G$	$C_7 = C_G$	$L_8 = L_C+L_H$	$C_8 = C_C$	$L_9 = L_B$	$C_9 = C_B$	$L_{10} = L_A$	$C_{10} = C_A$	$C_{11} = C_{12} = C_J$	$C_{13} = C_{14} = C_H$
800	722	1550	1038	2225	557	2890	152	7370	218	10560	716	5060	201	6660	637	6740	1038	2225	722	1550	3230	810
500	762	1675	960	2110	557	2890	160	7970	202	10000	716	5060	201	7065	637	6740	960	2110	762	1675	3530	504
350	786	1736	928	2045	557	2890	165	8260	195	9700	716	5060	201	7304	637	6740	928	2045	786	1736	3690	354
250	804	1785	900	2000	557	2890	169	8500	189·5	9500	716	5060	201	7476	637	6740	900	2000	804	1785	3790	252
150	812	1810	888	1975	557	2890	171·5	8600	186·5	9380	716	5060	201	7602	637	6740	888	1975	812	1810	3860	182

TABLE 5
Resonant Frequencies (kc/s)

BANDWIDTH (c/s)	L_1 & C_1 L_{10} & C_{10}	L_2 & C_2 L_9 & C_9	L_3 & C_3	L_4 & C_4	L_5 & C_5	L_6 & C_6	L_7 & C_7	L_8 & C_8
800	4·76	3·32	3·98	4·47	3·32	2·65	4·35	2·43
500	4·45	3·53	3·98	4·45	3·53	2·65	4·22	2·43
350	4·3	3·66	3·98	4·3	3·66	2·65	4·14	2·43
250	4·2	3·75	3·98	4·2	3·75	2·65	4·1	2·43
150	4·15	3·8	3·98	4·14	3·8	2·65	4·06	2·43

TABLE 6
Modified Components
(Inductors in mH, Capacitors in pF)

BANDWIDTH (c/s)	L_1 L_{10}	C_1 C_{10}	L_2 L_9	C_2 C_9	L_3	C_3	L_4	C_4	L_5	C_5	L_6	C_6	L_7	C_7	L_8	C_8	C_{11} C_{13}	C_{12} C_{14}
800	722	1550	1038	2225	557	2890	152	7370	218	10560	716	5060	201	6660	637	6740	3230	810
500	722	1765	1038	1950	557	2890	152	8460	218	9250	716	5060	201	7065	637	6740	3530	504
350	722	1890	1038	1830	557	2890	152	8970	218	8680	716	5060	201	7305	637	6740	3690	354
250	722	1985	1038	1735	557	2890	152	9400	218	8260	716	5060	201	7476	637	6740	3790	252
150	722	2030	1038	1690	557	2890	152	9640	218	8030	716	5060	201	7602	637	6740	3860	182

TABLE 7
Incremental Capacitors
*(Capacitors marked thus * are common to all bandwidths, rest are added to common capacitor)*

BANDWIDTH (c/s)	C_1 & C_{10}	C_2 & C_9	C_4	C_5	C_{11} & C_{12}	C_{13} & C_{14}	C_7
800	1550*	275	7370*	1310	3230*	306	6660*
500	215	120	1090	570	300	150	405
350	125	95	510	410	160	102	240
250	95	45	430	230	100	70	171
150	45	1690*	240	8030*	70	182*	126

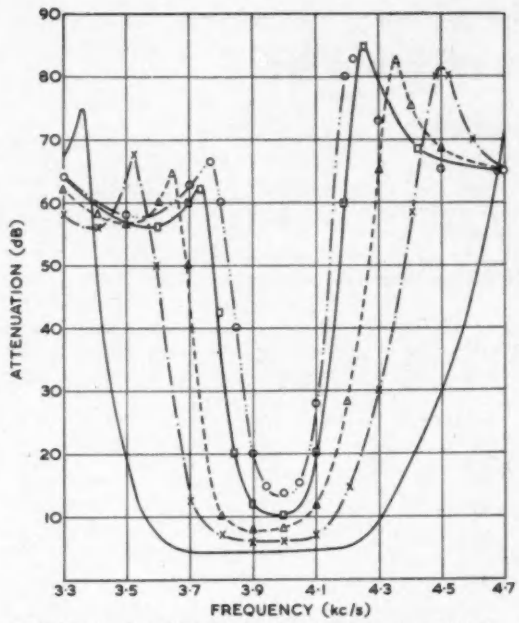


Fig. 9. Insertion loss characteristics of switched filter in a 2kΩ circuit

Since the calculated value of L_2 is 8mH resonating with a capacitance of 199 000pF, it is more convenient to increase the inductance and reduce the capacitance using the impedance transformer shown in Fig. 5.

For the widest bandwidth, let the inductor be increased to, say, 200mH, i.e. let the transformer ratio x be 5. L_{2k} now becomes $x^2 \times 8{\cdot}04 = 201$mH. Now, referring to equation (3), if the impedance has been varied in the same ratio as the bandwidth, then L_{2k} has varied in proportion to (Bandwidth)^2. Thus, in order to maintain the same value for L_{2k} for all bandwidths, the transform ratio x must vary in proportion to the inverse ratio of bandwidth, or, relating it to the value used for the widest bandwidth in the above example:

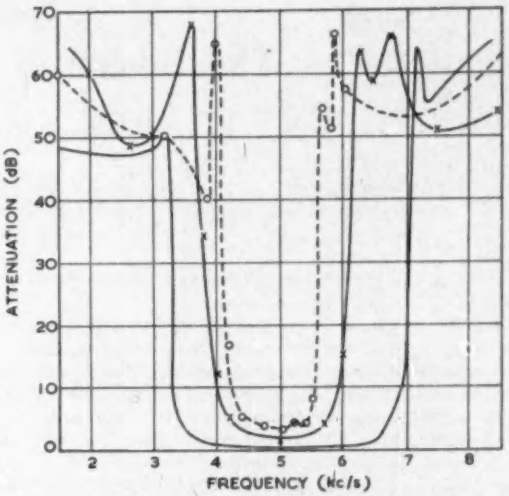


Fig. 10. Attenuation curve of a wide bandwidth band-pass filter
(Impedance switching of constant k section not used)

$$x = 5 \times \frac{800}{\text{Bandwidth (c/s)}}.$$

The element values for the constant k transformer, in the above example, are given in Table 2.

The calculated values for all bandwidths are set out in Table 3 to 7. The inductor values used in the final filter were those calculated for the widest bandwidth. The mean value of inductance, in each case, could have been used with similar results.

Fig. 9 shows the actual insertion loss curves obtained from the filter, which was used as an example.

Fig. 10 has been included to show the insertion loss characteristics of a filter having a wide bandwidth compared with centre frequency. The constant k transformer was not employed in that particular filter.

REFERENCES

1. Smith, J. E. Simplified Filter Design. (RCA Inst. Tech. Pros.).
2. Starr, A. T. Electric Circuits and Wave Filters. (Pitman).

A TRANSFER FUNCTION COMPUTER

The relationship between the input (excitation) and the output (response) of any control system is always of the form

$$A_0R + A_1(dR/dt) + A_2(d^2R/dt^2) \ldots\ldots A_n(d^nR/dt^n) = B_0E + B_1(dE/dt) + B_2(d^2E/dt^2) \ldots\ldots B_m(d^mE/dt^m)$$

where E = excitation and R = response.

The corresponding transfer function is

$$F(p) = \frac{B_0 + B_1p + B_2p^2 \ldots\ldots B_mp^m}{A_0 + A_1p + A_2p^2 \ldots\ldots A_np^n}$$

Thus if the coefficients A_0, A_1, A_2 ..... B_0, B_1, B_2, etc., belonging to the differential equation of the system can be measured, the complete transfer function is immediately known. Given the transfer function the roots of the denominator may be extracted and the complete behaviour of the system can be related directly to its physical parameters.

The production model of the Wayne Kerr Transfer Function Computer, which is now available, offers a direct means of measuring these coefficients and thus of establishing the transfer function in mathematical form.

The method of operation is briefly as follows.

A signal provided by the computer is applied to the system under test and the output of the system is fed back to the computer.

The primary function of the computer is to perform the necessary operations on the input and output signals of the system to produce an analogous differential equation. The coefficients in the analogous equation may be adjusted with precision to be identical with the corresponding coefficients in the system equation thereby giving a direct measure of the numerical values of the unknown coefficients. The process may be carried out rapidly in a systematic manner using the cathode-ray tube display which is incorporated in the instrument. The computer is designed to measure transfer functions having terms in the numerator and denominator up to and including fourth-order and sixth-order respectively. A sixth-order denominator is given as the product of a quadratic factor and a quartic factor which facilitates greatly the process of extracting the roots.

In addition to providing a new and direct method of measuring transfer functions, the self-contained instrument may be used also as a source of low-frequency signals. A four-phase sinusoidal output is available over the frequency range 0·01c/s to 5kc/s or alternatively repetitive impulse functions, square-waves and triangular waves are available. The instrument is thus a self-contained unit capable of displaying transient responses and also measuring phase-gain characteristics.

A Quick Method for
The Design of Butterworth Filters

By J. S. Bell*, A.M.I.E.E., A.F.R.Ae.S., A.M.Brit.I.R.E. and P. G. Wright†

The Butterworth type filter has several advantages over the more conventional filters for many applications. These are outlined, a design procedure is formulated and a practical design is considered using the methods given.

(Voir page 129 pour le résumé en français; Zusammenfassung in deutscher Sprache auf Seite 136)

FILTER design, is a specialized subject and even with a simple filter the newcomer may spend a considerable amount of time endeavouring to utilize a few components to their best advantage. The following work is the result of the authors' investigations into the suppression of r.f. interference. This revealed that there was apparently no accepted design procedure for Butterworth type filters. The methods of calculating the insertion loss of a ladder network are well known; the inverse, the design of a ladder network to give a desired insertion loss is not so well understood.

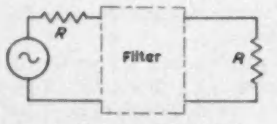


Fig. 1. Like source and load impedances

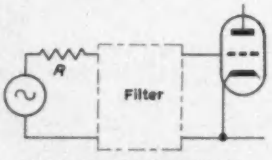


Fig. 2. Working into effective open-circuit

The Butterworth response was chosen because the design of anything but the simplest general response is a formidable task. In any case the response of the Butterworth filter, that is, a large degree of attenuation at one chosen frequency, little or a minimum at another frequency (known as the maximally flat response) is often the aim in many designs. The term frequency in this context also implies frequency bands.

In the particular application considered by the authors, that of r.f. suppression, there is no reason why other responses should not have been used except for the difficulties in their design.

In classical filter theory, perfect pass-bands are derived, but in the application of this theory the limitations of practical components, plus the effects of source and load impedances upset matters. However, by the selection of the maximally flat response, a practical yet efficient filter emerges which is comparatively easy to design besides giving a minimum amount of attenuation over the pass-band. The Tchebyshev response, which is closely related to the Butterworth response is not considered.

In general, the designer is asked to consider one of two particular cases and the discussion is limited to these. These are the maximum power transfer case (like source and load impedances) and the case of working into an open-circuit, e.g., the grid of a valve. Figs. 1 and 2 indicate these connexions.

Theory

Before proceeding further it is necessary to define insertion loss. This is an important definition as a filter cannot normally be considered as isolated from a circuit. The effect of the source and load impedances must be taken into account. Referring to Fig. 3 where a general

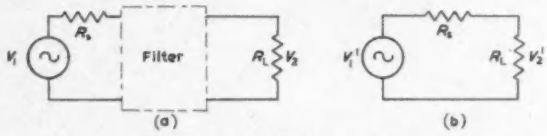


Fig. 3. Circuit with and without filter

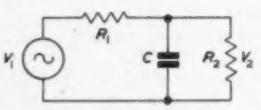


Fig. 4 First order filter

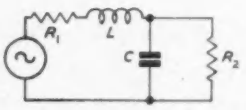


Fig. 5. Second order filter

circuit is illustrated with filter inserted and removed:—

$$\text{Insertion loss} = 20 \log \left| \frac{\frac{V_1}{V_2}}{\frac{V_1'}{V_2'}} \right| \text{ dB}$$

$$= 20 \log N \text{ dB}.$$

Consider now a general *LCR* filter with resistive source and load. After rationalization

$$|N|^2 = 1 + a\,\omega^2 + b\,\omega^4 + \ldots\ldots\ldots + k\,\omega^{2n}$$

where n is the number of reactive elements and the coefficients a, b, etc. are functions of the various L, C and R. For Butterworth response these values of L, C and R are such that the middle terms disappear. Hence if ω_0 is the frequency where the insertion loss is 3dB, the equation for the low-pass case is:—

$$\text{Insertion loss} = 20 \log \{1 + (\omega/\omega_0)^{2n}\}^{\frac{1}{2}}$$

$$= 10 \log \{1 + (\omega/\omega_0)^{2n}\} \quad \ldots\ldots \quad (1)$$

Equation (1) is of use in the design of a maximally flat response. Before pursuing this subject further consider the application of the argument to first and second order filters as represented in Figs. 4 and 5 respectively.

Applying conventional methods of analysis to Fig. 4

$$V_1/V_2 = \frac{R_1 + \dfrac{R_2/j\omega C}{R_2 + (1/j\omega C)}}{\dfrac{R_2/j\omega C}{R_2 + (1/j\omega C)}}$$

$$= R_1/R\ (1 + j\omega CR) \text{ where } R = \frac{R_1 R_2}{R_1 + R_2}$$

But $V_1'/V_2' = R_1/R$

* *Formerly Smith's Aircraft Instruments Ltd, now Fairey Aviation of Australia Pty. Ltd.*
† *Smith's Aircraft Instruments Ltd.*

Thus complex insertion loss ratio $= 1 + j\omega CR$

and insertion loss $= 10 \log (1 + \omega^2 C^2 R^2)$.

Let $\omega_o CR = 1$.

Insertion loss $= 10 \log \{1 + (\omega/\omega_o)^2\}$

It is seen that ω_o is the angular frequency where the insertion loss is 3dB, that is where $\omega = \omega_o$. Also as $\omega \gg \omega_o$ the integer becomes insignificant, that is if the graph of attenuation in decibels is plotted against frequency an eventual slope of 6dB/octave is obtained.

An examination of the second filter (Fig. 5) is slightly different from the first order case as it is now necessary to eliminate some of the terms. Where

$$R_1 = R_2 = R$$

$$N = 1 + j\omega (CR/2 + L/2R) - \omega^2 LC/2$$

Hence $|N|^2 = 1 + \omega^2 \dfrac{(CR - L/R)^2}{4} + \dfrac{\omega^4 L^2 C^2}{4}$

If $R = \sqrt{L/C}$ and $\omega_o LC = 2$

Insertion loss $= 10 \log \{1 + (\omega/\omega_o)^4\}$

Now, in general the designer would know the approximate pass-band required and the attenuation (B) in decibels desired at a particular frequency ω_1. A general formula for the number of elements required is obtained from equation (1).

$$\text{No. of elements } P = \tfrac{1}{2} \left\{ \frac{\log[\text{antilog } (B/10) - 1]}{\log (\omega_1/\omega_o)} \right\} \quad \ldots\ldots\ldots \quad (2)$$

Although an attenuation is being considered the sign of B is taken as positive. Although equation (2) is exact, n must be a whole number, therefore the value of n is the smallest integer greater than P. It follows that a saving in components may be achieved by making ω_o and B as small, and ω_1 as large as possible.

In the quick examination of the first and second order networks there was not a great deal of work involved. With succeeding orders the mathematics becomes more involved, though the general principal remains the same. Investigations have been carried out by Bennett[1], Green[2]. Weinberg[3] and Orchard[4] in this and allied fields and there is still much to do.

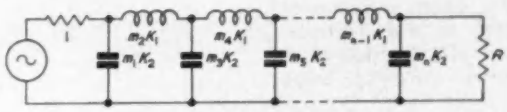


Fig. 6. Low-pass case 'n' odd

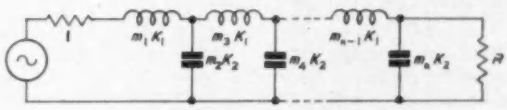


Fig. 7. Low-pass case 'n' even

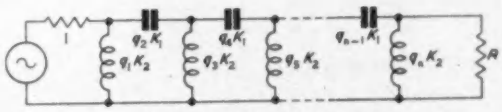


Fig. 8. High-pass case 'n' odd

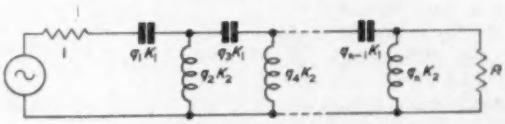


Fig. 9. High-pass case 'n' even

However, for the case considered tables from which the values of the reactive components may be obtained have been prepared. For simplicity the resistive source has been normalized. The low-pass case is given in Table 1 and the high-pass case in Table 2.

Figs. 6 and 7 illustrate the two forms of low-pass network for which the results are quoted and it should be specially noted that the n^{th} element is a capacitor. In Figs. 8 and 9 the corresponding high-pass networks are shown, inductors have been replaced by capacitors and vice versa.

TABLE 1

$R = \infty$ open-circuit case	$R = 1$ Max. Power Transfer
$m_1 = \sin \dfrac{\pi}{2n}$	$m_s = 2 \sin \dfrac{(2s-1)\pi}{2n}$
$m_2 \cdot m_1 = \dfrac{\sin \frac{3\pi}{2n} \cdot \sin \frac{\pi}{2n}}{\cos^2 \frac{\pi}{2n}}$	Note: $m_1 = m_n$, $m_2 = m_{n-1}$, etc.
In general $m_s \cdot m_{s-1} = \dfrac{\sin \frac{(2s-1)\pi}{2n} \sin \frac{(2s-3)\pi}{2n}}{\cos^2 \frac{(s-1)\pi}{2n}}$	Therefore in general $m_s = m_{n-s+1}$
Note that s is the sth element.	
If the source resistance $= R_o$ Then $K_1 = \dfrac{R_o}{\omega_o}$ and $K_2 = \dfrac{1}{R_o \omega_o}$ and all resistances are multiplied by R_o	

TABLE 2

$R = \infty$ open-circuit case	$R = 1$ Max. Power Transfer
$q_1 = \dfrac{1}{\sin \frac{\pi}{2n}}$	In general $q_s = \dfrac{1}{2 \sin \frac{(2s-1)\pi}{n}}$
$q_2 q_1 = \dfrac{\cos^2 \frac{\pi}{2n}}{\sin \frac{3\pi}{2n} \cdot \sin \frac{\pi}{2n}}$	Note $q_1 = q_n$, $q_2 = q_{n-1}$
In general $q_s q_{s-1} = \dfrac{\cos^2 \frac{\pi(s-1)}{2n}}{\sin \frac{(2s-1)\pi}{2n} \cdot \sin \frac{(2s-3)\pi}{2n}}$	In general $q_s = q_{n-s+1}$
Similarly for source resistance R_o $K_1 = \dfrac{R_o}{\omega_o}$ $K_2 = \dfrac{1}{R_o \omega_o}$ and all resistances are multiplied by R_o	

The design procedure is similar to that discussed previously, the number of elements required being calculated from

$$P = \frac{1}{2}\left\{\frac{\log\,(\text{antilog}\,(B/10) - 1)}{\log\,\omega_0/\omega_1}\right\}$$

Where n, the number of reactive elements required is the smallest integer greater than P. Actual values of reactive components are obtained by use of Table 2.

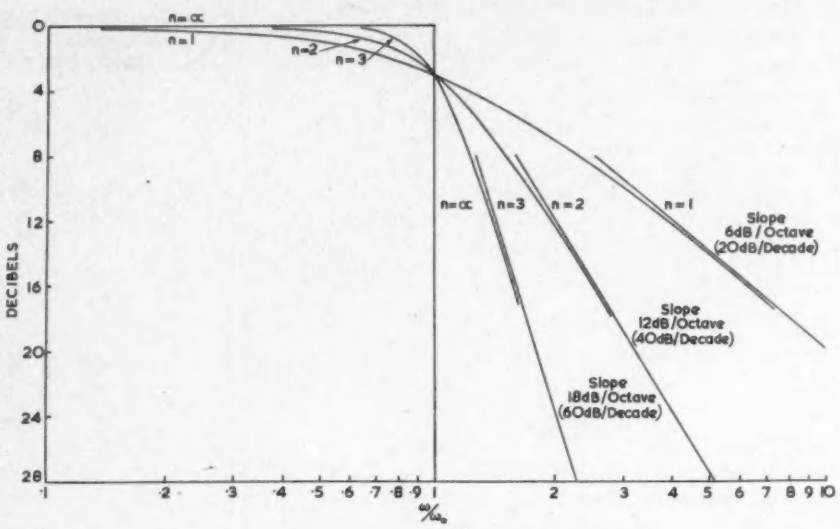


Fig. 12. Amplitude/frequency plots—various order networks

Design of a Practical Filter

A hypothetical filter is required to work between 600Ω resistors and is to have a pass-band up to about 18kc/s and yet is to give an attenuation of 40dB at 150kc/s.

This is the low-pass case and the number of elements must be determined from equation (2).

Substituting in this equation

$$P = \tfrac{1}{2}\left\{\frac{\log\,(\text{antilog}\,4 - 1)}{\log\,8{\cdot}33}\right\}$$

$$= 2{\cdot}17$$

Hence a third order network is necessary.

A quick check using equation (1) yields.

$$\text{Insertion loss} = 10\log(1 + 8{\cdot}33^6)$$

$$= 55\text{dB}$$

This is actually a greater loss than called for, but as can be seen the second order filter would not give enough attentuation. The case must thus be decided upon its merits, as, if the pass-band were made less than 18kc/s, then a second order network could be designed to give about, or exactly, 40dB at 150kc/s. However, let it be assumed that a loss greater than 40dB would be welcome,

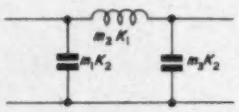


Fig. 10. Basic filter

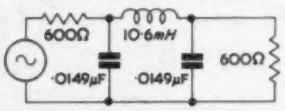


Fig. 11. Designed network

that is, a 3dB loss will occur at 18kc/s and 55dB at 150kc/s.

The basic filter is illustrated in Fig. 10 where the relative coefficients are as follows

$$\omega_0 = 18\text{kc/s} \qquad R_0 = 600\Omega$$

$$n = 3 \qquad s = 1$$

Using Table 1.

$$m_1 = 2\sin\left(\frac{\pi\,(2-1)}{2{\cdot}3}\right) = 1$$

$$m_2 = 2\sin\left(\frac{\pi\,(4-1)}{6}\right) = 2$$

and $m_1 = m_3 = 1$

$$K_1 = R_0/\omega_0 = \frac{600}{2\pi \times 18 \times 10^3} = 0{\cdot}0053$$

$$K_2 = 1/R_0\,\omega_0 = \frac{1}{2\pi \times 18 \times 10^3 \times 600} = 0{\cdot}0149 \times 10^{-6}$$

Thus $m_1 K_2 = m_3 K_2 = 0{\cdot}0149\mu\text{F}$.

And $m_2 K_1 = 2\,(0{\cdot}0053) = 10{\cdot}6\text{mH}$.

The filter is now designed and appears in its final form in Fig. 11 (though in practice a little rounding off in values may be permissible).

Finally the effects of adding reactive elements to a low-pass filter are considered. Graphs of chosen numbers of reactive elements plotted against a normalized frequency base and attenuation are shown in Fig. 12. It is seen that besides increasing the ultimate slope in 6dB/octave steps, the effect of additional reactive elements is to give a sharper cut-off, much sharper than would be obtained with a more conventional filter.

Conclusion

The elementary theory of the Butterworth response has been examined and a design procedure for certain ladder networks formulated. This design procedure assumes that the last reactive component of the ladder is shunted by the load impedance, the general case has not been presented and in fact has not yet been fully worked out as far as the authors are aware.

A typical design problem has been examined and a network derived in order to illustrate the method formulated.

Acknowledgment

The authors wish to thank Mr. G. G. Roberts, formerly Technical Director of Smith's Aircraft Instruments Ltd for his kind permission to publish this article, and Mr. N. L. Sigournay for reading the proofs.

REFERENCES

1. Bennett, W. R. Transmission Network. U.S. Patent 1, 788, 538 (1931).
2. Green, E. Amplitude-Frequency Characteristics of Ladder Networks. (Marconi Wireless Telegraph Company, England.)
3. Weinberg, L. Explicit Formulas for Tschebyscheff and Butterworth Ladder Networks. *J.R.E. Nat. Convention Record. 5*, Pt. 2. 200 (1957).
4. Orchard, H. S. Formulae for Ladder Filters. *Wireless Engr. 30*, 3 (1953).

Short News Items

The English Electric Co. Ltd are now manufacturing as standard equipment, a high-performance punched paper tape reader, originally designed for use with the DEUCE computer. The reading speed is up to 1 000 characters per second, and the tape can be stopped from full speed after reading any character, without losing the next. It can be started and stopped to a maximum of 30 times per second. A simple adjustment is provided to accept tapes of standard widths with five, seven, or eight code holes, and tape may be used from any stock, subject certain limitations on translucency. The reader is being fitted to the recently announced KDF 9 data processing system, and will provide a main channel for manually prepared data and programme.

The British Radio Equipment Manufacturers' Association has formed a Public Relations Committee to fill the gap created by the demise of the Public Relations Committee of the Radio Industry Council which, as the Publicity Sub-Committee of the R.I.E. Organizing Committee, is now solely concerned with the Radio Show.

The Television Society has invited Sir Harold Bishop, C.B.E., M.I.E.E., Director of Engineering, BBC, to become President in succession to the late Sir George Barnes, M.A., D.C.L. Sir Harold Bishop has been with the BBC since it was the British Broadcasting Company Ltd in 1923. He has been Director of Engineering since 1952. Sir Harold Bishop, who was the Senior Vice-President, took office on 8 December of last year.

Ultra Electronics Ltd are to purchase a one-third share in Miles Electronics Ltd. The two companies jointly designed and manufactured the De Havilland Sea Vixen Radar Simulator equipment and are now developing the Radar Simulator for the Blackburn Buccaneer coming into service with the Royal Navy. Miles Electronics has also produced advanced nuclear Reactor Simulators which have been purchased by major British Companies and exported to Europe.

Birmingham University is to hold a one-day symposium on "Computers for the Chemical Engineer" on 28 March 1961. It is being organized by the Birmingham University Chemical Engineering Society, Graduate Section and the Graduates and Students Section of the Institution of Chemical Engineers, Midlands Centre. The papers to be presented are intended to show how computers can be of benefit to Chemical Engineers, and are of a descriptive nature. The morning session will cover the principles of computers and their application to plant management and research. The afternoon papers will show the use of computers in process control. Further information may be obtained from the Registration Secretary, Department of Chemical Engineering, The University, Edgbaston, Birmingham, 15.

The General Electric Co. Ltd and A.B. Electrolux of Sweden, whose British subsidiary is Electrolux Ltd announce the conclusion of an agreement by which they will associate jointly in the development of the thermoelectric refrigerator. It is believed that this association will lead to the quicker exploitation of the many possibilities opened up by the introduction of practical thermoelectric refrigeration.

The Department of Scientific and Industrial Research has set up a Working Party to consider national needs in the field of scientific film. It is especially interested in the aspects of film as a research tool and in communicating research results. To assist the Working Party the Department, in co-operation with the other Research Councils, the Atomic Energy Authority and some Government Departments, is circulating a questionnaire to industry, universities and research organizations. In this way it is hoped to reach all those engaged in the serious use of film in this field; who hold stocks of interesting research film or who have developed unusual techniques and applications. Anyone who can contribute to this enquiry, but who has not received the questionnaire, is invited to contact the Information Division, Department of Scientific and Industrial Research, 14-18 Cornwall Terrace, N.W.1.

The C.S. "Retriever"—a new cable repair ship—was launched at Birkenhead in December last and will be commissioned in April this year. Her owners, Cable and Wireless Ltd, state that she will be the Company's first ship to be designed and constructed for the recovery and overboarding of the new coaxial type telephone cables with submerged repeaters. With a gross tonnage of about 4 000 tons, she will have an operating range of 8 000 miles, a maximum speed of 15 knots, a sea endurance of seven weeks, and a cable capacity of 21 000ft³ (420 miles of conventional deep-sea cable) in three tanks.

The 1961 International Solid-State Circuits Conference will be held at the University of Pennsylvania, Philadelphia, on 15 to 17 February and will cover in the formal sessions the broad advances in the field of solid-state device applications and circuits. Forty-nine papers covering new device characteristics, microwave amplifiers and applications, logic, computer magnetics, power and control, storage, communication circuits and techniques, and new technologies will be offered. Also presented will be a number of invited papers on special topics. Eleven informal sessions will be held at the Sheraton Hotel. Further information can be obtained from Lewis Winner, 152 West 42nd St, New York, U.S.A.

The Second International Measurement Conference (IMEKO) is to be held in Budapest on 25 June to 1 July this year when it is expected that some 120 papers will be presented on the theoretical and practical aspects of design of a wide range of measuring instruments. An International Measurement and Instrument Show (IMIS) will be held simultaneously with the Conference. Further information may be obtained from the IMEKO Secretariat, Budapest 5, P.O. Box 3.

Ekco Electronics Ltd have been awarded contracts for the supply of Airborne Weather Radar equipment for the Ministry of Aviation AWA660 aircraft. The AWA660 is the military version of the Armstrong Whitworth 'Argosy' Freighter.

Marconi Instruments Ltd under a recent agreement with Computer-Measurements Company of Sylmar, California, will manufacture the latter Company's range of transistorized electronic counters. Marconi Instruments will enjoy world selling rights outside North America and Japan. The agreement covers a 10 year period, and also includes provision for the exchange of engineering information in the field of related transistorized products.

Decca weather radar is now being installed at Frankfurt, Hanover, Hamburg, Munich and Schleswig airports. The installations are nearing completion at Frankfurt and Hamburg and will shortly be evaluated by the German Meteorological Service prior to being taken over by local aviation weather services. The fitting of weather radar at Frankfurt, in particular, is of special significance because of the air traffic control problems associated with this busy air terminal. At

Frankfurt, Hamburg and Hanover the radar aerials are being mounted on specially erected towers, and installation is being carried out by Telefunken G.m.b.H., of Ulm.

Livingston Laboratories Ltd, London, have announced that a range of Tektronix oscilloscopes are now being made at Guernsey in the Channel Islands. The first Guernsey productions to qualify under Commonwealth Preference Regulations are types 515A and 545A, together with a wide range of plug-in units. These oscilloscopes are now available in Britain and the Commonwealth, without the problem of obtaining duty remission.

Marconi's Aeronautical Division is now being regrouped in new premises at Basildon, Essex, where the bulk of the company's aeronautical equipment is manufactured and a new extension has now been completed to house the entire division. In addition to commercial and administrative offices, it contains new laboratories and workshops for the Development Groups, including specially equipped environmental testing and aerial design laboratories. The Systems Planning Group, the Servicing and Maintenance Group, the Spares Department, the Training School, and the Technical Information Group will also move into the offices at Basildon.

General Controls Ltd of Basildon, Essex, have just completed a Servo Gang Wirewound Potentiometer with 294 tapping points. The unit has been made for a special computing application, and consists of 14 gangs of their PR.35 series each gang having 20 segments, i.e. 21 tapping unit per gang. Each tap has been individually welded on to a selected turn of the winding, to ensure accuracy in electrical positioning of the taps. This potentiometer has a low operating torque for a 14 ganged unit of 2oz/in.

The Centre d'Information des Techniques Industrielles has set up a library at its headquarters at 35 Rue d'Amsterdam, Paris 8, containing the world's principal technical journals. The C.I.T.I. which is a non-profit making organization invites manufacturers to supply catalogues and technical information relating to their products.

Members of London Transport's Electronic Data Processing Unit and E.M.I. Electronics Ltd have been jointly investigating the possibility of compiling automatic timetables by computer for use on London's bus service and they have now succeeded in compiling and printing, on an Emidec 1100 computer, in 30 seconds, a timetable for the simplest type of bus route, which would take a schedule compiler at least an hour to produce manually in rough outline. In order to gain an insight into the problem, the simplest type of bus route—from A to B, without any intermediate turning points or branches—was taken as a basis, and the logical rules underlying the compilation of a timetable for such a route were determined. From these rules, a detailed computer programme was built up. This programme needs to be written only once, since it will accept variations in specifications for different routes. The computer can then compile the complete timetable for a particular route in 10 seconds, and immediately print out the information in as many different forms as are needed. There is an even greater saving in time when producing the subsidiary documents than there is in printing the time schedule. The next problem is to define the logic and write the computer programmes for the more complex types of timetable, comprising several intermediate turning points, two or more garage allocations, and inter-working requirements where several routes follow the same path over parts of the journeys. When this task is completed the London Bus Service will be the first in the world to be operated by timetables compiled entirely by computer.

Marconi Instruments Ltd, St. Albans, has received contracts worth approximately £100 000 from Supreme Headquarters Allied Powers Europe for telecommunications test gear to be used on the "ACE HIGH" project. Included in the contracts are a number of White Noise Test Sets, Signal Generators covering both the v.h.f. and u.h.f. bands, and Universal Bridges.

The Electrical Research Association announces that Mr. L. Gosland has been appointed Deputy Director. This appointment is additional to his position of Research Manager, which he will continue to hold. Mr. C. G. Garton and Mr. E. W. Golding are appointed Assistant Directors of the E.R.A. Mr. Garton will continue as Head of the Materials Department of E.R.A. and Mr. Golding will continue as Head of the Rural Electrification Department, and also as Overseas Liaison Officer.

Ericsson Telephones Ltd of Beeston, Nottingham, announce the development of a reversible Dekatron circuit applicable to Dekatron types having electrical connexions to only one output cathode. The circuit requires five triode sections per decade, and a number of close tolerance resistors. When output signals from '9' and '0' are available, it is possible to construct a very simple scaler with wide component and operating tolerances as follows: The add and subtract inputs are fed via suitable networks into the units Dekatron, and are also connected to the two inputs of a bistable pair. The two outputs from this stage remember whether the input pulse is to be added or subtracted. A standard carry circuit arranged for positive carries is connected between cathode '0' of Dekatron stage n and the guides of stage $n + 1$; and an identical circuit to give negative carries is interposed between cathode '9' of stage n and the guides of stage $n + 1$. The 'inhibit' bias of all positive stages is derived from the subtract output of the bistable stage, and similarly all negative carries are inhibited by the bistable add signal.

An Ekco Automatic V.H.F. Direction Finding Equipment has been installed at Coventry Airport as part of the plan to expand Coventry's facilities for handling increased air traffic.

The 1961 IRE International Convention will be held at the Waldorf-Astoria Hotel and New York Coliseum on 20 to 23 March. A comprehensive programme of 275 papers, covering the most recent developments in the fields of all 28 IRE Professional Groups, will be presented in 54 sessions at the Waldorf-Astoria and the Coliseum. The IRE Show, filling all four floors of the Coliseum, will accommodate approximately 850 exhibitors. Some $15M worth of the latest electronic equipment will be on display, most of it for the first time.

Thermionic Products (Electronics) Ltd have recently installed a fully transistorized multi-channel recorder at Ronaldsway Airport (I.O.M.). The equipment is a two bay installation providing recording for 24 hours continuously, of eight communications channels and a time signal reference channel with an automatic spare channel reserved for emergency operation. Half inch wide tape is used to accommodate the 10 simultaneously recorded tracks. Extensions at a later date to wider tape and up to 20 tracks are possible on this equipment.

Manufacturers applying for space in the Radio and Electronic Component Show to be held at Olympia, London, from 30 May to 2 June 1961, now number 241, the space booked being nearly 68 000ft². This is nearly double the number of exhibitors and space applied for when the last announcement was made last November. A number of applicants have asked for increased space, and several firms are applying for more than 1 000ft² and one for 4 000ft².

Airmec Ltd of High Wycombe have recently delivered by special messenger two Essen Ring Crystals to Japan to be installed in Airmec Standard Frequency equipment in Japanese astronomical observatories. The crystals are so delicate that they have to be carried by hand in a sponge rubber lined case the whole way to their final destination. Delivery of these two crystals brings the total number of Essen Ring oscillators in Japan to seven. These oscillators, which are the most

stable in the world, are used both as time and frequency standards. Those already delivered to Japan have stabilities in the region of one part in 10^{10} per day. Other countries to which Essen Ring crystals have been delivered include Canada, U.S.A., Belgian Congo, India, Switzerland, Belgium and Sweden.

The Transmission Division, Telephone Manufacturing Co. Ltd have built a portable battery operated harmonic analyser for the British Transport Commission, to British Post Office electrical design for tests on the 50c/s electrification of the Colchester-Clacton-Walton railway line. The analyser is used to measure the magnitude and frequency of harmonic interference from electrified traction and power distribution cables into adjacent telecommunication systems. Normally, waveform analysis is a slow and laborious process, but the new instrument greatly facilitates the work, as it is arranged to measure and display selected harmonic amplitudes, continuously and simultaneously. The instrument is fitted with indicating meters, but output terminals are provided to enable the outputs to be fed through a translator for permanent record by a digital recorder. The meters, arranged on the front of the analyser provide a simultaneous display of the fundamental and each of the 11 harmonic voltages. By photographing all the meters together a permanent record of the harmonic relationship at any particular instant can be made.

The Derritron Electronics Group are being joined by three new companies to make a total of 10 companies, all of which specialize in various fields of non-domestic electronic equipment. The new additions are Beulah Electronics Ltd, Direct TV Windings Ltd and Direct TV Replacements. Other companies already in the Group are: BEME Telecommunications Ltd, Chapman Ultrasonics Ltd, Doran Instrument Co. Ltd, Reslosound Ltd, L.S.B. Components Ltd, BEME Research and Development Ltd and Electronic Vibrators Ltd.

A Group of senior engineers is being formed by Decca Radar Limited to inaugurate the Company's research and development effort in the space electronics field. The group will shortly be transferred to new laboratory premises in the Isle of Wight on the Company's development site at Somerton Airport, Cowes. It is expected that initial programmes will include tracking systems and low noise receiving systems.

The Special Projects Department of I.C.T. has been awarded a contract by the Ministry of Aviation for the design and manufacture of equipment that will record the output of precision tracking radar. The final purpose of the equipment is the recording on punched cards of the radar's output which consists of digital measurements of the azimuth, elevation and range of the radar beam together with voltage signals representing the angular distance of the target from the centre of the beam. Because the radar data has to be examined at high rates an intermediate stage of recording on magnetic tape with slower replay into punched card equipment is necessary. The readings of the position of the beam itself will be recorded in digital form directly on the magnetic tape, while the voltage error signals will first be converted to digital form by high-speed digital to analogue convertors before being recorded simultaneously on the same tape. The whole equipment will use solid-state techniques and at each stage a measure of self-checking will be incorporated so that a high degree of operation reliability is to be expected.

Marconi's Wireless Telegraph Co. Ltd are at present engaged on an extensive Air Ministry contract which involves the supply and installation of new radio communication equipment and automatic direction finders, and the modernization and installation of Admiralty ranging and height-finding radar for high altitude windfinding aboard two new Ocean Weather Ships. The radio equipment for these two ships includes the following, divided equally between each: 8-1kW independent sideband transmitters Type NT201. These are medium power transmitters in the frequency range 1·8 to 23Mc/s, 16—receivers Type NS702, providing a continuous coverage from 15kc/s to 28Mc/s, 2—medium frequency Direction Finders Type ND103, 2—u.h.f. automatic Direction Finders Type AD210C.

Mr. J. W. Ridgeway, O.B.E. (A.E.I.), has been elected chairman of the Radio Industry Council in succession to Mr. E. E. Rosen (Ultra). Mr. Ridgeway was chairman, R.I.C., from 1948 to 1952. Mr. A. L. Sutherland (Philips Electrical), who is at present chairman of the British Radio Equipment Manufacturers' Association, has been appointed vice-chairman. Mr. R. Kelf-Cohen, C.B., who became Acting-Director of the Radio Industry Council on the death of Sir Raymund Hart last year, has been appointed Director and Secretary, R.I.C.

"Science and Industry—The Problem of Communication"—will be the theme of a two-day national conference—to be held at the Brangwyn Hall, Swansea, on 18-19 April. Aimed at industry, especially firms in the rapidly expanding industrial areas of Wales, it will deal extensively with the many problems of disseminating research results. It is being organized by the Department of Scientific and Industrial Research, with the assistance of a local advisory committee under the chairmanship of Sir Maynard Jenour. About 300 delegates from industry and industrial research organizations are expected to attend. The conference fee is 5 guineas, and those interested in attending are advised to apply without delay to the D.S.I.R. Liaison Officer for Wales, Block II, Government Buildings, Gabalfa, Cardiff.

Cossor Communications Co. Ltd of Stanmore, Middlesex, have designed a range of pocket-size v.h.f. radio telephones for use by Police Forces, Security Guards, Airport Services, Fire Brigades, and for all applications where low weight, small dimensions and reliability are major considerations. The equipment is fully transistorized; receivers obtain power from re-chargeable nickel cadmium batteries, while transmitters employ all dry mercury cells. Equipments for customer evaluation purposes will include the Series CC.1, a.m. receiver, the Series CC.5, alarm receiver, and the Series CC.7, 150 milliwatt transmitter. An f.m. receiver, the Series CC.2, will be available shortly. Where size and weight are not the major consideration, Cossor can offer the Series CC.3, a.m. packset, which weighs 5 lb—in complete working order.

The Electronics Group of the Institute of Physics and the Physical Society are holding a one-day meeting on Tunnel Diodes in conjunction with the British Institution of Radio Engineers. The meeting which will be held on 7 February at the Headquarters of the Institute and Society, 47 Belgrave Square, London, S.W.1, will cover the physical characteristics and circuit applications of tunnel diodes which have developed rapidly in the last two years. Attendance will be by ticket only for which application should be made to either of the sponsoring organizations. The lecture room will accommodate 100 only and early application is therefore advisable.

A National-Elliott 803 electronic digital computer has now been installed in the Central Research Institute of Complex Automation, Moscow, and has been running on a two-shift timetable since 22 August, when it was formally handed over. This 803 Computer was exhibited in Moscow at the recent British Scientific Instrument Manufacturers' Association Exhibition by the Computing Division of Elliott Brothers (London) Limited, a member of the Elliott-Automation Group. It is a standard machine, with a 4 096 word magnetic core store, paper-tape and punched card inputs, and a paper-tape output channel.

BOOK REVIEWS

Analogue Computers

By L. I. Eterman. 264 pp. 115 figs. Demy 8vo. Pergamon Press Ltd. 1960. Price 56s.

THIS book is a welcome addition to the range of English translations of Soviet technical literature now becoming available.

Intended for the mathematician, it attacks in a rigorous and comprehensive manner the mathematical difficulties which arise in programming d.c. analogue machines. From a brief survey of dynamic system theory in terms of phase trajectories, the author proceeds to examine in detail methods by which non-linear multi-variable system equations may be recast into sets of single variable functions which may be simulated by realizable analogue elements, a process usually associated with tedious trial and error solutions or, lately, with analysis using digital computers.

As a necessary corollary, the author devotes a chapter to the errors arising from analogue solutions and proposes unique methods whereby the analogue computer may be programmed to calculate its errors following the solution of a problem. A valuable supplement to this is provided in an appendix tabulating solutions of test problems suitable for machine checking.

The sections on practical functional units and machines, presumably included for completeness, are weak and appear outdated against modern practice. This, however, does not detract in any way from the value of the book.

A comprehensive set of references provides a useful guide to Soviet publications in this field.

K. H. SIMPKIN

Elektronische Hilfsmittel des Physikers (Electronic Aids for the Physicist)

By W. Gruhle. 179 pp. 166 figs. Demy 8vo. Springer-Verlag, Berlin. 1960. Price DM 29.60.

THIS small pocket book is intended as an aid to physicists seeking a solution to electronic measurement problems. An attempt is made to give a basis for designing circuits rather than a résumé of circuits already designed. As space is limited, many important elements such as magnetic amplifiers and transistor circuits are left out which, with regard to their almost universal use at the present time, appears to be rather unfortunate. The main interest is focused on pulse circuits with particular reference to their applications in nuclear physics.

After an opening chapter on circuit elements, signal generators including transducers, multivibrators and other pulse generators, trigger circuits and radiation detectors are discussed. Further chapters deal with the attenuation, amplification, combination and registration of signals, integrating and differentiating circuits being included.

The author has had an unenviable task in fitting a large amount of material into a small space. The result is that the text is rather difficult to follow as it is interlaced with cross references and formulae. It is felt that a clearer delineation between theory and its application as well as the introduction of a few time-saving concepts such as, for example, the 'see-saw' treatment of negative feedback amplifiers would have eased matters. A very useful bibliography containing some 360 references is appended.

A. S. HAY

Translation from Russian for Scientists

By C. R. Buxton and H. S. Jackson. 299 pp. Demy 8vo. Blackie and Son Ltd, 1960. Price 30s.

THIS book is designed primarily to enable the scientist to acquire a reading knowledge of the Russian language. It contains the alphabet, which is introduced by means of scientific words that are similar to their English counterpart, and essential grammar and translation passages taken from various scientific spheres. The book is intended not only for scientific purposes but also as a more detailed study of the language.

Einführung in Die Programmierung Digitaler Rechenautomaten (Introduction to the Programming of Digital Computers)

By F. R. Güntsch. 139 pp. Medium 8vo. Walter De Gruytest Co, Berlin. 1960.

THE use of digital computers as self-evident and essential tools in technical and scientific undertakings, in commercial accountancy and in administration has brought a rapidly increasing number of people into contact with these machines who have to familiarize themselves with the technique of their application.

Thus this introduction to the programming of digital computers is not intended only for students but also for those who use computers in their professional work or plan their application and wish to evaluate their possibilities. To cater for so diverse a circle of readers no mathematical knowledge has been presupposed with the exception of a few elementary concepts.

The most important programming techniques, like cyclic programming, provision of sub-programs, employment of symbolic addresses, interpretation programs and super programs are discussed in such a way as to enable the reader to arrive by himself at the special techniques best suited to the various computer types and problems. The book provides worked-out examples and problems which facilitate the complete understanding of the text. The examples have been prepared with the Z 22 in mind which has found such wide distribution in German speaking countries and particularly in universities.

Electrical Who's Who 1960-61

566 pp. Medium 8vo. Electrical Review Publications Ltd. 1960. 6th Edition. Price 35s.

THIS edition contains about 9 000 entries, covering men and women in all branches of the electrical industry, transport, mining and trade associations. Electrical engineers in the Post Office, the Admiralty, the Ministry of Supply and other Government Departments are also included. Brief biographies give particulars of education and careers. These are supplemented by an index to the entries, classified under the names of their companies or other organizations, thus making it easy to ascertain the names of the principals of a particular concern and from there refer to the biographical entries.

Applied Boolean Algebra: An Elementary Introduction

By F. E. Hohn. 139 pp. Med. 8vo. The Macmillan Co., N.Y. & London. 1960. Price 17s. 6d.

THIS book provides a simple introduction to the basic facts of Boolean algebra and some of its applications. It is intended for both mathematicians and engineers and hence assumes no special engineering or mathematical background.

The book begins with the algebra of relay circuits. The algebra of propositional functions and logic circuits and the algebra of the subsets of a set are next developed. Finally there is an introduction to the map method of simplifying Boolean functions. This is intended to provide an intuitive background for a study of the minimization problem, of which a bibliography is given.

Analog Computation in Engineering Design

By A. E. Rogers and T. W. Connolly. 450 pp. 249 figs. Medium 8vo. McGraw Hill Publishing. 1960. Price £6 4s.

THE objective of the authors in writing this book was to show how a general purpose analogue computer may be used to solve problems connected with various branches of industry. They have been successful!

The illustrative problems are so varied that most engineers who read this book

will be able to follow the way in which a general purpose analogue computer may be used to investigate a problem connected with their own particular branch of engineering. The range of problems will also make the book valuable as a reference to analogue computer operators.

The first part of the book deals with the principles, capabilities and limitations of the general purpose analogue computer. This is followed by a discussion of typical equations which may be encountered in the field of engineering design and shows how they may be solved by analogue computation. Analytic methods of obtaining solutions to these equations are also discussed.

Finally a variety of real problems from industrial sources are analysed to show the power of the general purpose analogue computer as a design tool and to illustrate efficient problem preparation and computer solution.

The text of this book is written in a style which makes it easy to read. It has clear, well annotated diagrams although, unfortunately, these sometimes appear overleaf from their place in the text.

This book is particularly recommended to engineers who wish to know the uses to which analogue computers may be put: it is not, and does not set out to be, a manual of their use.

L. H. DOE

Solid State Physics in Electronics and Telecommunications, Vol. 2, Semiconductors, Part 2

Edited by M. Désirant and J. L. Michiels. 645 pp. 485 figs. Royal 8vo. Academic Press, London. New York. 1960. Price £6 8s.

THIS, the second volume of papers presented at the Brussels Conference in 1958, concerns itself with semiconductor compounds and semiconductor applications and devices. Of the 72 papers included about 40 are in English, the rest being in French and German—a reflection of the International nature of the conference. Although the worthwhile work reported at the conference has been published elsewhere by now the collection of related topics in one volume makes this book, like its fellow volume, invaluable to specialist research and development workers.

The papers on compounds reveal a distinct preferential interest in indium antimonide and cadmium sulphide, with indium arsenide and zinc sulphide as runners-up. Gallium arsenide, a compound of some technological interest today, is scarcely mentioned. Perhaps most intriguing is the work described in several papers on galvanomagnetic effects in indium antimonide and indium arsenide and the uses which can be made of these phenomena. Six papers deal with semiconductor applications to such problems as earth satellite instrumentation and computing elements, and these are followed by 27 papers on devices whose subjects range over transistor theory, negative impedance (but no tunnel diodes at that time), high frequency operation, and the conversion of nuclear energy to electrical energy. The volume ends with six papers on power rectifiers.

There is one major error of presentation—nowhere does one find a summary at the beginning of a paper. Since only a few authors have drawn conclusions at the ends of their papers this omission is particularly noticeable. Otherwise the book is very well produced. Perhaps, after two years of incubation, it ought to be.

B. K. RIDLEY

Solid State Physics in Electronics and Telecommunications. Volumes 3 and 4. Magnetic and Optical Properties, Parts 1 and 2

Edited by M. Désirant and J. L. Michiels. 557 pp. 414 figs. and 404 pp. 293 figs. Royal 8vo. Academic Press, London, New York, 1960. Price £6 8s. 6d. and £5 14s. 6d.

IN these two volumes the papers dealing with magnetic and optical properties of solids, which were read at the International Conference on Solid State Physics in Brussels in June 1958, are presented. There are 52 papers in volume 3 apportioned under the following subheadings: Ferrites (13), Properties of Magnetic Materials (8), Applications of Magnetic Materials (21), Garnets (5), Magnetic Resonance (5). Of these, 28 are in English, 14 in French and 10 in German. In volume 4 there are 49 papers: Masers (5), Electroluminescence (11), Phosphors (6), Applications of Photosensitive Materials (5), Miscellaneous Problems (17), Radiation Damage (5). In this volume 25 papers are in English, 15 in French and 9 in German. In the Miscellaneous section several of the papers deal with the effects of particle bombardment on the properties of ferrites and semiconductors. The discussions of papers are not included.

In assessing the value of this work it seems appropriate to quote from the Foreword—"Since a major object in this publication was speed, no attempt has been made to standardize notations and so on, the papers having been prepared according to the customs prevailing in the country of origin". More than two years have elapsed since the conference, so that the uniformity which critical editing would have produced has apparently been sacrificed in vain. Although a standardization of notation and symbols is perhaps not essential in a work of this kind a uniformity of style is desirable. In this respect some papers fall short of the standard which would be acceptable to the Editors of first class scientific journals in this country. This is unfortunate since the presentation in these volumes is similar to that in scientific journals (i.e. we have a somewhat heterogenous collection of separate papers) and must be judged in comparison with these rather than with text books.

In summary it may be said that the books fall between two stools. On the one hand the long delay in publication makes them somewhat unsatisfactory from the point of view of topicality. On the other there has been a minimum of editing, with consequent detraction from a uniformity which is desirable in permanent texts.

It must be said, however, that the volumes are very well produced. They contain many papers of merit and will no doubt have particular appeal to participants of the conference.

F. J. HYDE

An Introduction to Electrotechnology

By S. J. Kowalski. 301 pp. 217 figs. Demy 8vo. Chapman & Hall Ltd. 1960. Price 35s.

THIS work covers approximately the requirements of Part One: Applied Electricity, for the London B.Sc. (Eng.) degree. It is based on lecture courses given by the author to students of the Polish University College, London.

The discussion of electric and magnetic fields is more detailed than is usual in introductory texts, and the development of electromagnetic theory has been based to some extent on logical arguments to provide a useful physical background to the analysis of electromagnetic phenomena.

EE 30 117 *for further details*

CHAPMAN & HALL

Selected Books from our List

Electronic Measuring Instruments
E.H.W. BANNER *2nd Ed. 56s.*

Reflex Klystrons
J. J. HAMILTON *45s.*

The Cathode-Ray Tube and its Applications
G. PARR & O. H. DAVIE *2nd Ed. 50s.*

Encyclopaedia on Cathode-Ray Oscilloscopes and their Uses
J. F. RIDER & S. D. USLAN *2nd Ed. 10gns.*

Noise in Electronic Circuits
A. VAN DER ZIEL *80s.*

(Particulars of the above and other books will be sent on request)

37 ESSEX STREET, LONDON, W.C.2

EE 30 118 *for further details*

From the Russian

Physics of Semi-Conductors

★

Philips Technical Library

Prof. A. F. IOFFE provides an exhaustive discussion of these materials and examines many kinds of semiconductors and their uses.

500 pp. 155 diags. **84s.**

Magnetrons

K. HINKEL's clear and well illustrated account of their applications, physical background and properties.

102 pp. 62 illus. **21s.**

Tube Selection

T. J. KROES's **Tube and Semiconductor Selection Guide, 1960-61** gives details of current Philips tubes in clear tabular form. 160 pp. **12s. 6d.**

Cornelius on m.k.s.

P. CORNELIUS **Electrical Theory on The Giorgi System** relates this to modern electrical problems and supplies valuable conversion tables.

187 pp. 28 illus. **32s.**

Thyratrons

C. M. SWENNE's lucid account of these fast switching devices, widely used in modern industry.

106 pp. 68 illus. **12s. 6d.**

Using Transistors

D. J. W. SJOBBEMA outlines their theory and describes some typical and effective circuits.

120 pp. 120 illus. **15s.**

Multivibrators

P. A. NEETESON's **Analysis of Bistable Multivibrator Operation** examines these electronic switching circuits, used in a variety of pulse apparatus.

82 pp. 41 illus. **15s.**

CLEAVER-HUME PRESS LTD.
31 Wrights Lane, London, W8.

Electronic Equipment Reliability

By G. W. A. Dummer and N. Griffin. 274 pp. 71 figs. Demy 8vo. Sir Isaac Pitman & Son Ltd. 1960. Price 45s.

AS is to be expected from authors whose background has been concerned with the Royal Radar Establishment of the Ministry of Aviation there is a strong bias in this book towards Ministry specifications and the stringent requirements which such specifications engender.

Essentially a practical work, the 11 chapters made up of 274 pages cover a wide aspect on the subject of reliability in all manner of electronic components.

The first chapter deals with the reliability problem as such, and then goes on to discuss major causes of unreliability.

The second chapter investigates the problems of failure criteria which naturally leads to a discussion on faults in components, cables, sleeving, etc.

The authors then introduce the effects of severe environmental conditions including humidity, high temperature, high altitude, storage, shock and vibration, following which is a chapter devoted to the effects of reliability on constructional techniques including printed circuits, encapsulation, and solderless wrapped connexions, to name but a few of the many items considered.

Attention is paid in two consecutive chapters to testing and design respectively, both electrical and mechanical, which are followed by a chapter on human engineering, indicating how design is affected by human limitations.

Twenty-three pages are devoted to reliability prediction and calculation and there is a well thought out chapter at the end of the book on future trends including micro-miniaturization methods.

The texts is very readable and there is scarcely a page that does not contain either a photograph, diagram or chart of some kind.

The subject of Electronic Reliability is a vast one but the authors seem to have tackled it very commendably, and successfully brought together under one cover an important part of the mass of both classified and unclassified data on this subject. The book should prove to be an essential guide to design engineers and a worthwhile addition to technical libraries.

R. H. MAPPLEBECK

Magnetyczne przekaźniki bezstykowe (Magnetic Contactless Relays)

By A. Góral. 248 pp. 128 figs. Pott 4to. Wydawnictwo Ministerstwa Obrony Narodowej, Poland. 1960.

THE book deals with the properties of relatively new devices—magnetic contactless relays, these being defined by the author as magnetic bistable or bistate elements which have no moving mechanical parts and being magnetic field sensitive.

Three main topics are covered: the materials and components used for the construction of magnetic relays: bistate and bistable magnetic amplifiers: the logical aspects of magnetic relays.

The book is primarily intended for engineers working in the field of telecommunications, electronic computers, automation and remote control. Because the treatment is rather simple the book will appeal to a wider readership interested in the problems mentioned.

Engineering Management

By Struan A. Robertson. 467 pp. 12 figs. Demy 8vo. Blackie and Son Ltd. 1960. Price 30s.

THE text of this book is founded on lectures given to University, Higher National Certificate, and Diploma in Technology engineering students, and to those studying for the Institution of Mechanical Engineers' examination in Industrial Administration.

The book deals with the art of management, the science of management and the practice of management.

The 'Advance' Science Masters Handbook

Compiled by I. L. Muter. 120 pp. 136 figs. Demy 8vo. Advance Components Ltd. 1960. Price 12s. 6d.

THIS book is intended to help science masters to demonstrate the theory taught during their lectures. It covers a complete series of experiments in general electronics theory and sound and wave motion, together with relevant facts and figures which should prove useful.

An Introduction to the Cathode-Ray Oscilloscope

By Harley Carter. 132 pp. 99 Figs. Pott 4to. Cleaver-Hume Press Ltd. 2nd Edition. 1960. Price 15s.

ADDITIONS have been made to the text of this second English edition to include further information or explanations suggested by readers. Chapter 8, 'Some Complete Oscilloscope Circuits', has been largely rewritten, and some of the circuits described in the first edition have been replaced by new or revised designs which incorporate many interesting and novel features and employ the latest types of tubes.

The Cathode Ray Tube Memory of the High-speed Electronic Computer of the U.S.S.R. Academy of Sciences

By V. N. Laut and L. A. Lyubovich. 90 pp. 71 figs. Med. 8vo. Pergamon Press Ltd. 1960. Price 35s.

THIS book is compiled from a series of papers which describe the internal memory based on cathode-ray tubes of the type used in the high-speed computer potentioscope.

The design and construction of this memory unit was carried out by a group of engineers under the leadership of Academician S. A. Lebedev, the chief constructor of the high-speed computer. The reader is taken through all the stages of this engineering feat to the final chapter on operational experience and conclusions.

LETTERS TO THE EDITOR

(We do not hold ourselves responsible for the opinions of our correspondents)

Stabilized Voltage Supplies Using Transistors

DEAR SIR,—Having read the article by Messrs. Bell and Wright (December, 1960) I feel that some further explanation is necessary regarding the first system.

In dual high voltage regulated supplies utilizing this technique, it is important that the positive supply convertor be driven, as shown in the circuit diagram, due to the possibility of interaction which is introduced through magnetic coupling between convertor transformers running at slightly different frequencies. This interaction appears in the forms of a beat frequency oscillation on both supplies, the resultant amplitude variations having been observed to exceed 100V peak-to-peak.

In a similar unit which is under development at present, the stability against input voltage variations which is determined by the reverse resistance of the starting diode, using the circuit shown in the article, has been found to exceed 2 000:1 but a further improvement can be made, if required, by including a current operated relay with a normally closed contact in series with the starting diode and the coil in series with the supply input. Theoretically, this increases the stability factor to infinity and measurements with a decade voltmeter capable of measurement to 1mV have indicated no observable change in the reference voltage of a 150V unit with an input variation of ±50 per cent on a nominal input voltage of 28V, i.e. stability against input voltage changes exceeds 28 000:1.

Yours faithfully,

R. J. GALBRAITH,
Short Brothers and Harland Limited,
Belfast.

The Author Replies:

DEAR SIR,—I agree that in circuits of the first type described, it is essential that the positive supply convertor be driven, in order to avoid interaction which can, as Mr. Galbraith states, be considerable. How much of this interaction is due to magnetic coupling, and how much due to direct ohmic coupling in the reference lines and comparators, is a point upon which, at the moment, I would not commit myself.

As stated previously, the driven convertor transformer must not be allowed to saturate; i.e. the product of primary turns, saturation flux density, and effective core area for the driven transformer must not be less than the similar product for the master convertor transformer.

Mr. Galbraith's suggested method for obtaining a high stability factor appears very useful, particularly if the operating conditions are such that a relay could be chosen which would operate on the no load current and yet be robust enough to carry the full load current without damage.

I would point out that in the particular design described in the article, the supply voltage cannot be reduced below about 25V without causing considerable variation in the output, as the convertors were designed to produce the required voltage for about 24V at the output of the series stabilizer. If the supply voltage is liable to fall by a large amount, then the convertors must be made capable of operating at the lowest possible input voltage expected. The power dissipation of the series stabilizer elements must also be matched carefully if any large supply variations are anticipated.

Yours faithfully,

P. G. WRIGHT,
Smith's Aircraft Instruments Ltd,
Cheltenham,
Gloucestershire.

Read-out Systems for Transistor Scalers

DEAR SIR,—Mr. Benbow's article entitled, "Read-out Systems for Transistor Scalers" in the December 1960 issue, refers to three types of indicator suitable for this purpose.

There is however, a fourth method which we think has considerable interest. The Mullard DM160 subminiature voltage indicator was introduced specifically for this type of application. It operates from a 50V h.t. supply, and requires a 3V change at the grid to switch it from the 'off' to the 'on' condition. The control grid can, therefore, be connected directly to the collector of the transistor without an intermediate driver stage as is required by either the neon lamp or filament lamp method. The indicating strip is 10 by 5·5mm and gives a blue/green indication.

Yours faithfully,

V. T. ROLFE,
Mullard Limited,
London, W.C.1.

The Author Replies:

DEAR SIR,—Thank you for a sight of Mr. Rolfe's letter regarding the DM160 indicator tube, which is in use at the Atomic Weapons Research Establishment. In my particular application reduction of display system area is most important particularly for the five-decade read-out on which the survey was based, and the use of a two-terminal indicator makes very small mechanized assembly possible. The provision of a further voltage supply rail for a thermionic indicator filament, in this case a total demand of 0·60A would be undesirable. Since the writing of the article the Texas 2S701 silicon switch at one third of the price of the 2S001 has become available and now makes the neon indicator method economically comparable with the use of the DM160. There is no doubt, however, that the DM160 will be used in many other applications here.

Yours faithfully,

T. G. BENBOW,
Nuclear Instruction Section,
U.K.A.E.A. Aldermaston.

The Anode-Cathode Follower

DEAR SIR,—Messrs. Vincent and Kaine, in their article which appeared in the April 1960 issue, have endeavoured to show how simply the overall gain of their anode-cathode follower circuit can be derived.

I have made efforts to apply their reasoning but cannot succeed in achieving the equation (1) presented in the article.

Mr. Thompson's letter, in the September 1960 issue, explaining how to tackle this question is of fundamental importance and I would appreciate a similar lucid exposition by the authors.

Yours faithfully,

G. M. WARD,
Calcot, Reading.

Dr. Vincent states in reply that the best way to answer Mr. Ward's letter would be to write a short article explaining the method fully from the beginning, and applying it to the anode-cathode follower as an example.

Dr. Vincent's manuscript has now been received and will be published in a forthcoming issue.—EDITOR.

ELECTRONIC EQUIPMENT

A description, compiled from information supplied by the manufacturers, of new components, accessories and test instruments.

(Voir page 123 pour la traduction en français ; Deutsche Übersetzung Seite 130)

SELECTIVE MICROVOLTMETER

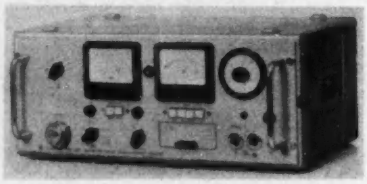
(Illustrated below)

Distributed by: Aveley Electric Ltd, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex

The 'Selektomat' type USWV manufactured by Rohde and Schwarz is a measuring superheterodyne receiver with an electrically tuned local oscillator. Although primarily designed as a complementary instrument to the 'Polyskop,' it can be used with any sweep or standard signal generator operating within the frequency range.

The frequency range of 30 to 400Mc/s is sub-divided into seven ranges, and tuning can be carried out manually or automatically, the automatic tracking circuits locking on to the selected frequency which is fed into the input.

The minimum input is 10μV r.m.s. frequency response is 0·2 per cent/Mc/s ±1dB, and input attenuation 0 to 60dB. The bandwidth is 125kc/s (3dB down) and 1Mc/s (80dB down). The logarithmic indication is 0 to 80dB and the linear



indication, 0 to 20dB with the additional 60dB attenuator.

The 'Selektomat' is ideal for frequency response measurement on 2- or 4-terminal networks, e.g. filters, amplifiers and attenuators; measurements of the input reflection on 4-terminal networks and the reflection coefficient on aerials using reflectometers, etc.

EE 30 751 *for further details*

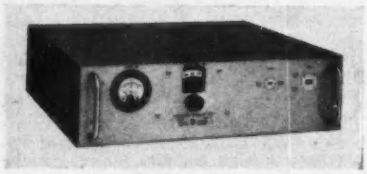
S.H.F. SIGNAL SOURCE

(Illustrated above right)

Distributed by: Livingston Laboratories Ltd, Retcar Street, London N.19

A system of wide-band power generation at microwave frequencies has been evolved by the Hewlett-Packard Company. The frequency range 18·0 to 40Mc/s is covered by two frequency doublers types 938A and 940A. Model 938A provides power from 18 to 26·5Mc/s, when driven by a 9 to 13·25kMc/s source. Model 940A, 26·5 to 40kMc/s when driven by a 13·25 to 20kMc/s source.

The frequency doubler units consist essentially of broadband crystal harmonic generators suitably mounted in waveguide. Also incorporated is a power monitor and precision attenuator. Both units may be driven by klystrons, signal generators, or sweep oscillators. Since both models 938A and 940A are broad-



band instruments, the input signal may be c.w., pulsed or swept. The output signal therefore retains the facilities of the driving source.

Both frequency doublers have built-in power monitors and precision rotary vane attenuators which allow accurate level setting from 0 to −100dB with an absolute level accuracy of ±1dB at most frequencies. The incremental attenuator accuracy is 2 per cent of the reading or ±0·2dB whichever is greater and the output v.s.w.r. is of the order 2:1 at maximum output and less than 1·2:1 with the attenuator set at −10dB or more.

A typical figure for conversion efficiency is 16dB at 10mW input.

EE 30 752 *for further details*

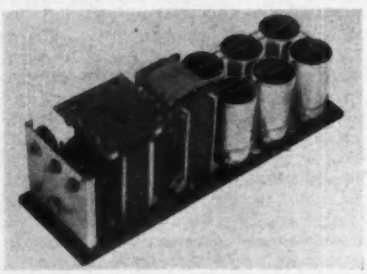
STABILIZED D.C. POWER SUPPLIES

(Illustrated below)

Claude Lyons Ltd, Valley Works, Hoddesdon, Hertfordshire

This new range of stabilized d.c. power supplies is intended for incorporation in a manufacturer's own equipment.

The supply consists of a conventional d.c. power supply (step-down) transformer, bridge rectifier and reservoir capacitor smoothing), the input to which is fed through a transductor. A transistorized feedback amplifier measures the output voltage from the supply and continually adjusts the d.c. in the control winding of the transductor so as to maintain the output voltage constant over a wide range of variation in input (mains)



ELECTRONIC ENGINEERING will occupy a stand at LE SALON INTERNATIONAL DES COMPOSANTS ÉLECTRONIQUES to be held in Paris from 17 to 21 February, and visitors will be welcome

voltage and frequency, and in output (load) current.

The supply has no valves and is of very high reliability. Ripple is low—of the order of 1 per cent. The output voltage is adjustable over a range of ±15 per cent about the nominal value. A high degree of protection against short-circuits is an inherent feature.

The types so far available have the following outputs: 12V at 8A, 20V at 5A, 24V at 4A, 32V at 3A and 48V at 2A.

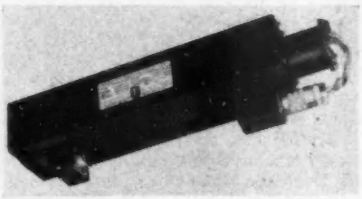
EE 30 753 *for further details*

VARIABLE MAGNETOSTRICTION DELAY LINE

(Illustrated below)

Ferranti Ltd, Hollinwood, Lancashire

Magnetostriction delay lines in which mechanical pulses are transmitted along wires have been used for some years for storage and time delay purposes in computers, simulators and other electronic systems. Only recently have the



techniques for giving continuous variation of time delay been sufficiently developed to make possible a reliable manufactured article.

Ferranti Electric, Inc. of New York have recently introduced a variable magnetastriction delay line which is available with delays variable throughout the range of 2μsec to 10msec. The digit rate of the line is up to 500kc/s and the fluctuation in delay time is less than 1mμsec. Settings of delay time are linear and reproducible to an accuracy of 0·1 per cent.

Continuous variation of the delay time is obtained by a mechanical control, through a low-torque, recirculating ball-race drive, suitable for manual or servo operation. Microswitches provide an electrical indication of when the limits of variation are reached, and mechanical end stops prevent over-driving.

EE 30 754 *for further details*

THERMOCOUPLE CONNECTOR

West Instruments Ltd, Regent Street, Brighton, Sussex

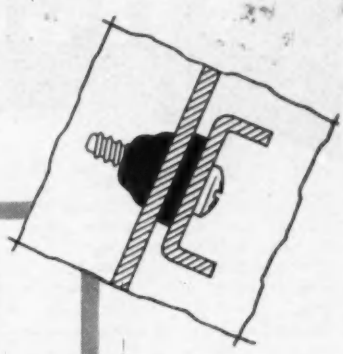
This thermocouple plug is oil- and water-tight and is claimed to eliminate the errors often introduced at the union with extension wiring.

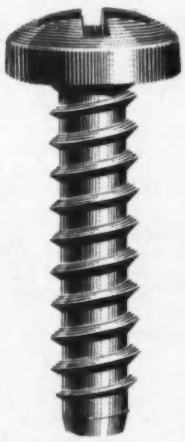
It is suitable for terminating thermocouples so that a quick and easy con-

The answer to one-sided assembly fixing–

GKN

introduce new low-cost, high-speed fasteners, designed for fixing from one side of an assembly. Simple, positive, robust and time-saving fasteners for general application in all industries.





NPK
SELF TAPPING SCREW

INSULGRIP
SHOCK & VIBRATION PROOF FASTENER

- **No tapping**
- **Assembly from one side**
- **Insulated fixing**
- **High strength/weight ratio**
- **No special tools required**
- **Vibration-proof**
- **Clips in position and cannot fall out**
- **Dust and waterproof**
- **Low cost**

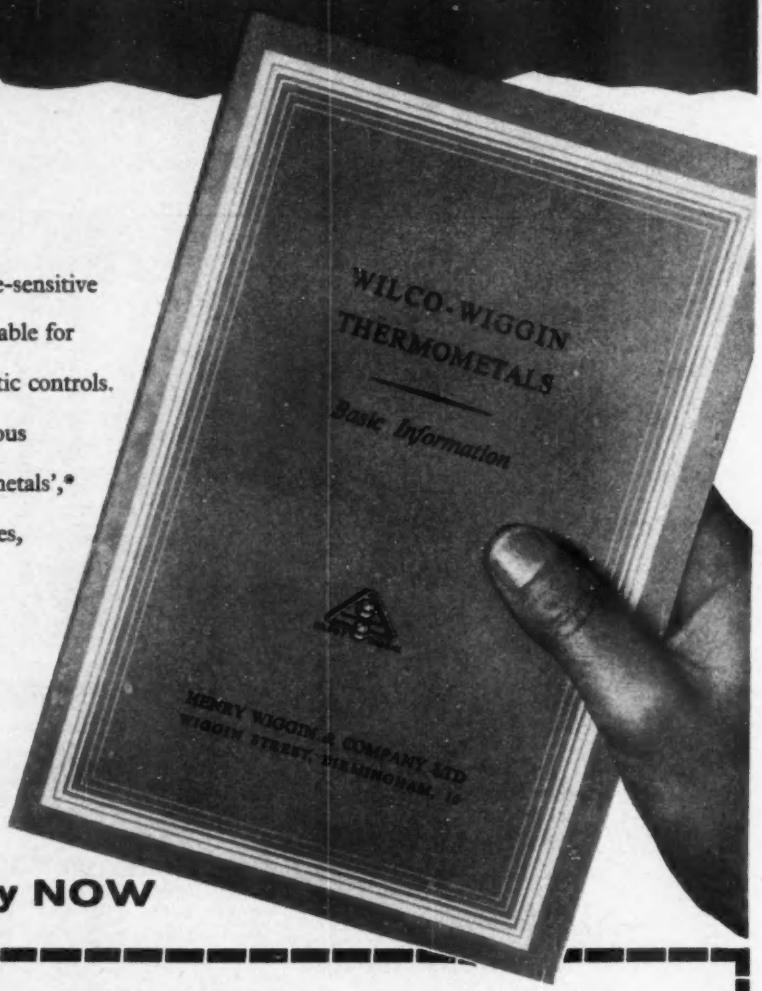
Full technical details on request.

IF IT'S A MATTER OF FIXING ONE THING TO ANOTHER—GET IN TOUCH WITH **GKN**

GEORGE GOODMAN LTD

ROBIN HOOD LANE · BIRMINGHAM 28 · TELEPHONE: SHIRLEY 4491

Thermometals



THERMOMETALS are temperature-sensitive bimetals produced in several grades suitable for use in a wide variety of thermostatic controls. This new publication describes the various grades of 'Wilco-Wiggin Thermometals',* with tables of thermal properties, design formulæ for various types of mechanism, and details of fabrication and heat-treatment.

*TRADE MARK

Send for your copy NOW

TO HENRY WIGGIN & CO. LTD. WIGGIN STREET BIRMINGHAM 16

Please send me a copy of your new booklet WILCO-WIGGIN THERMOMETALS — BASIC INFORMATION

NAME _____

APPOINTMENT OR DEPARTMENT _____

COMPANY AND ADDRESS _____ EL/M31/2

HENRY WIGGIN & COMPANY LIMITED · WIGGIN STREET · BIRMINGHAM 16

TGA 1121

nexion can be made to extension lead-wire. Thermocouples can be replaced without disturbing what may be a complicated and expensive run of leadwire. It also eliminates the need for terminal strips and other types of connectors which could cause errors because of vibration, dirt and other factors.

The pins and sockets of the connector are made of selected materials to prevent spurious e.m.f.'s being produced as a result of temperature gradients over the plug and socket. The connectors are also polarized to prevent faulty connexions.

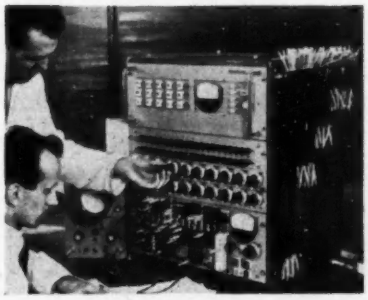
EE 30 755 *for further details*

ANALOGUE DESK COMPUTER

(Illustrated below)

Telefunken, GmbH, Berlin, Charlottenberg, 1

The desk analogue computer type RAT 700 is a completely transistorized d.c. computer. It is built up of sub-units which permit the assembly of analogue computing equipment of any desired size and capacity, starting with individual computing elements up to large computing installations.



Several computers can be connected in parallel and remote control is likewise possible. The output oscilloscope OMS 700 was especially developed for the desk computer.

One Type RAT 700 computer contains the following units, according to choice:

10 to 15		operational amplifiers, of which
6 to	8	can be switched over as integrator/summator
4 to	7	as summator
0 to	4	multipliers
	20	potentiometers (2 types)
0 to	2	function generators
	8	diodes
0 to	2	relays

Computing resistors and also two capacitors for each integrator are incorporated in the equipment. The operational amplifiers are chopper-stabilized so that, in addition to repetitive and single operations, long-time computations are also possible.

The exclusive use of transistors ensures a high reliability of operation. The equipment is comparatively light (80kg), while its low power consumption (90VA) renders ventilating or air-conditioning systems superfluous.

EE 30 756 *for further details*

AIRBORNE TAPE RECORDER

(Illustrated below)

Sir W. G. Armstrong Whitworth Aircraft Ltd, Baginton, Nr. Coventry, Warwickshire

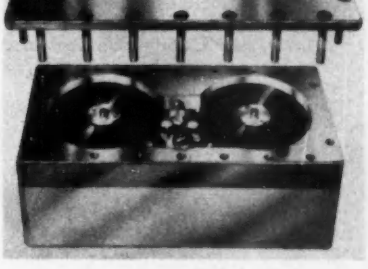
This airborne tape recorder was developed for use in missiles fired over the Woomera land range.

A carrier frequency of 50kc/s is recorded to saturation level in both positive and negative direction on 3 or 7 tracks of ¼in or ½in magnetic tape fed past the recording heads at 75in/sec. The data to be recorded is used to frequency modulate this carrier between the limits of 35 and 65kc/s; i.e., with a deviation frequency of ±15kc/s. The 4th or 8th track is used to record a crystal-controlled 100kc/s reference signal which is used during playback to measure the frequency of the data channels as a submultiple of its own frequency and to provide elapsed time marking. It will be seen, therefore, that the accuracy of frequency measurement is controlled by the reference signal and not by the tape speed, though it is necessary to hold the latter to fairly close limits. The frequency modulated tracks, of which there are three on ¼in tape and seven on ½in tape, are known as 'data tracks'; the fourth or eighth respectively is called the "reference track' and is also used to record a 'zero time marker' to identify the start of the data recording and of elapsed time counting.

The recorder deck is fairly conventional in appearance, consisting of a friction loaded feed spool, a motor-driven capstan driving the tape past the recording head by means of rubber pinch wheels and steel rollers. The pinch wheels are engaged by an eccentric cam and a take-up spool driven by a separate d.c. motor. The main capstan motor is controlled in speed by an electronic field supply control unit deriving its input information from a pulse switch on the motor shaft. The take-up motor speed is controlled only by the tape tension.

The tape spools are specially fabricated to withstand flight accelerations and vibration forces and to assist in protecting the tape against impact forces. These later are taken up mainly by the high tensile steel tape deck and covering lid.

The motors projecting from the deck and the all-transistor electronic circuits are housed in a light steel case attached to the base of the recorder deck. All these units can shear off at impact and are assumed to be non-recoverable. Impact velocities of about 400ft/sec into hard packed earth and stores and decelerations between 2 500 and 3 500g have been sustained by the recorders and the tapes recovered in perfect condition.



EE 30 757 *for further details*

THERMOCOUPLE OVEN

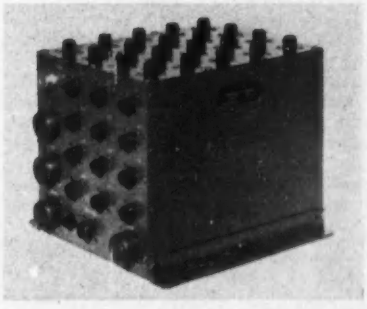
(Illustrated below)

George Kelk Ltd, 5 Lesmill Road, Don Mills, Ontario, Canada

A reference thermocouple oven which will house reference junctions for as many as 48 measuring thermocouples of various types and weighing less than 8 lb is manufactured by George Kelk Limited. The use of a separate junction for each thermocouple eliminates errors resulting from grounded thermocouples.

Temperature of the reference junctions is held constant within 0·5 per cent for a wide range of ambient temperatures.

Suitable individual thermocouple alloy connectors are provided for connexion to external thermocouples with multiple connectors for output circuits. The unit can be supplied for use with a.c. or d.c. power.



EE 30 758 *for further details*

LOW RESISTANCE BRIDGES

(Illustrated on page 118)

Startronic Ltd, 117a Malden Road, New Malden, Surrey

The model 100 is a low resistance measuring bridge covering a range of 0·05Ω to 50kΩin five double decade ranges with an accuracy of 0·5 per cent. The instrument has a base size 5in × 7½in with the panel sloping from 4in high at the rear to 2in at the front for ease of use, and is powered by an internal heavy duty 4·5V battery.

The calibrated dial is 4in diameter and null indication is via a high grade, mirror scale moving-coil meter. The standard resistors employed are better than 0·1 per cent.

The instrument can also be supplied with single decade ranges giving a total coverage of 0·05Ω to 5kΩ, either version being ideal for goods inwards inspection, production testing or laboratory work.

Two variations of the instrument are also available, model 108 and model 110, both in the same type instrument case.

The model 108 has a single range of 0 to 160Ω with an accuracy of ±1mΩ or ±2 per cent depending on the part of the scale being used. Measurements can be made with 0·1A, 0·2A, 0·3A or 0·6A flowing through the resistor being measured. There is provision for direct measurement at the end of test leads having a total resistance of 10mΩ. The instrument can be used for measurement of contact and bonding resistance.

The model 110 is a comparison bridge directly calibrated ±10 per cent with terminals for external standards together with provision for up to four switched internal standards to specific requirements. The scale is calibrated in 0·1 per cent steps up to 1 per cent and 0·5 per cent steps between 1 per cent and 10 per cent. The calibration accuracy is 0·1 per cent up to 5 per cent and 0·2 per cent between 5 per cent and 10 per cent and the range is from 5Ω to 10kΩ.

EE 30 759 *for further details*

PHOTO-TRANSISTOR 'SERVO-POT'

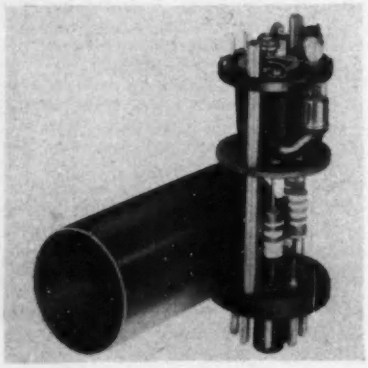
(Illustrated below)

Sangamo Weston Ltd, St. George's Court, 22-26 New Oxford Street, London W.C.1

This model is basically a d.c. amplifier utilizing a photo-transistor and a galvanometer in a bridge circuit which is arranged to give a current output directly proportional to the millivolt input. An advantage of the circuit arrangement is that no appreciable current is drawn from the input source.

The 'Servo-Pot' is designed for connexion to a 24V d.c. supply and to give a standard output of 1mA for an input of 10mV. The base consists of an octal plug, and the case is approximately 3in in length by 1 3/16in diameter.

EE 30 760 *for further details*



DIGITAL CLOCK

(Illustrated below)

Microcell Electronics Ltd, Blackwater, Camberley, Surrey

This unit has been developed as a module for the Microcell type 300 data logger alarm scanning system, and fits standard 19in racking. It is also available as a self contained instrument.

Basic drive frequency at 50c/s is derived from the mains, and this is divided down in transistor stages to 1c/s. Subsequent frequency division is carried out on miniature plug-in uniselectors to give hours, minutes and seconds.

A six decade digital display shows the time as hours, minutes and seconds and output is available on 6 of 45 lines to operate a printing device.

Programmed time intervals giving a contact closure or voltage pulse can be called up at 1, 2, 5, 10, 20, 30, or 60min intervals by selection of appropriate switch positions. In addition the same contact closure or voltage pulse can be given at precise hourly times by merely putting a pin in a 24 position miniature pin board e.g. typical programmed times such as 0000, 0600, 0800, 1100, 1500, 1800 can be called up.

EE 30 761 *for further details*

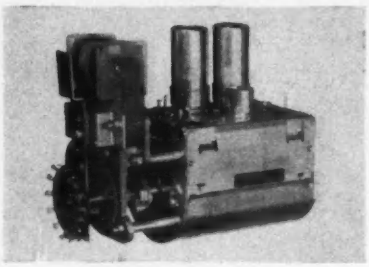
MINIATURE LF. TRANSFORMERS

(Illustrated above right)

The Wireless Telephone Co. Ltd, Vicarage Lane, Ilford, Essex

The Wireless Telephone Company Ltd, one of the Plessey Group of Companies, has introduced a new range of miniature bandpass intermediate frequency transformers. These are intended for portable transistorized receivers with intermediate frequencies within the range 450 to 480kc/s. Chief feature of the new transformers is the parallel mounting of the coils which gives stable coupling and compact assembly. The ferrite cup cores are potted in an epoxy resin to give good mechanical rigidity with resistance to vibration. Can size has been reduced to 1 1/16in × ¾in × 11/16in high.

Double tuned transformers are used in the first two stages and a single tuned unit in the third stage and i.f. alignment is carried out by adjustable dust cores. These are mounted in a novel way; in place of the normal threaded core a plain core is bonded to a polystrene screw working in a threaded hole



in the coil former. This provides a robust adjusting screw for operation by conventional metal bladed screwdrivers and this design allows the cores to be wax sealed after final trimming.

The transformer for the third stage has the diode and r.f. by-pass capacitor mounted inside the shielding can.

EE 30 762 *for further details*

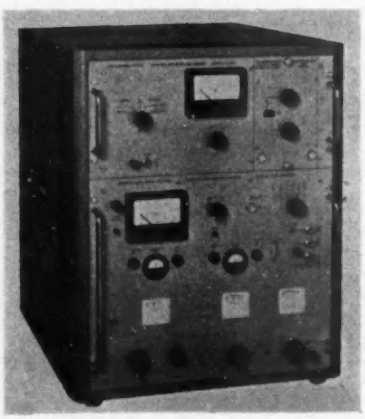
CRYSTAL CONTROLLED SIGNAL GENERATOR

(Illustrated below)

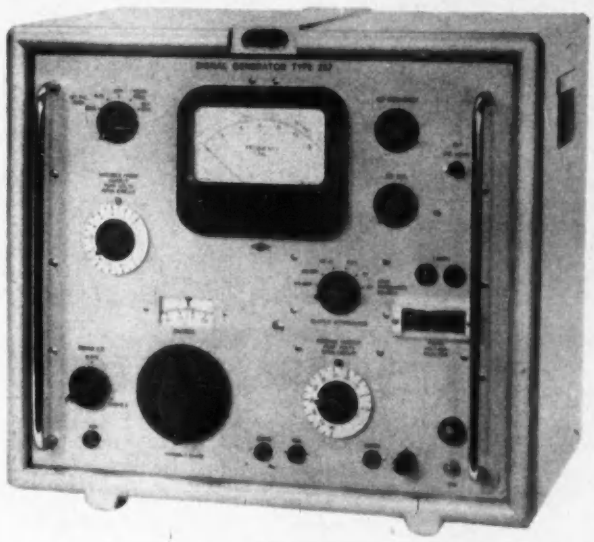
Solartron Elektronik GmbH, Munich 15, Bayerstrasse 13

This instrument, which has been developed by the German section of the Solartron Organization, is based on the beat-frequency oscillator principle. In practice, the output frequency of 50kc/s to 50Mc/s is produced as a difference of a fixed crystal-controlled frequency of 105Mc/s. and a variable, but also crystal-controlled, frequency of 105·05 to 155Mc/s.

This principle has the advantage that any kind of modulation can be applied to the fixed frequency of 105Mc/s, while the output frequency is determined by the setting of the variable-frequency oscillator. The frequency of this oscillator is controlled by means of a frequency synthesis system, which allows the variable frequency to be set in steps of 10kc/s with the full accuracy of a built-in control crystal. The gaps between these 10kc/s lock-points can be covered by a high-precision variable-frequency oscillator (v.f.o.) which gives a frequency shift of the lock-points from −3kc/s up to +13kc/s.



Points to note when choosing a V.L.F. signal Generator



V.L.F. SIGNAL GENERATOR Type No. 257

Can you change level and frequency instantaneously? Because of the long time-constants involved, adjustments of level and frequency on almost all V.L.F. Signal Generators take minutes to become effective. This irritating time-wastage has been eliminated on the Airmec V.L.F. Signal Generator Type 257 (0·03—30 c/s) by using a unique system for generating the output signals. The basic generator employs a motor-driven capacitor to modulate a high frequency signal which is then rectified and amplified to provide the very low frequency output. Hence frequency changes are made instantaneously by changing the motor speed and level setting is effected instantaneously by altering the RF signal level.

Is harmonic distortion low at all frequencies? Some V.L.F. Signal Generators only quote distortion figures at relatively high frequencies. This is understandable since with RC oscillators distortion normally worsens as the frequency is lowered and measurement of harmonics at very low frequencies is not easy. The purity of the waveform generated by the V.L.F. Signal Generator Type 257 is dependent only on the shape of the modulating capacitor vanes, and distortion (less than 2%) is therefore constant at all frequencies.

Is a quadrature output available? A quadrature output is now generally regarded as essential and is provided on many of the more expensive signal generators. The 257 has both a Reference Output (in phase with the normal output) and a Quadrature Output (lagging 90° on the normal output). These two additional signals have a useful level of 15 volts and are invaluable when measurements of phase are required to be made on very low frequency systems.

Is a Variable Phase Output available? In addition to the three outputs mentioned above the V.L.F. Signal Generator Type 257 is unique in providing an output the phase of which can be varied continuously over the range 0—360° by means of a calibrated control. This facility is obtained by rotating one of the pick-up stators of the modulating capacitor and the phase is therefore independent of both level and frequency.

Can Signals be obtained over a wide voltage range? Step and slide wire attenuators on the 257 enable the output to be set accurately to any voltage between 0·5 millivolts and 50 volts peak. The impedance is normally 10 k/ohms but a position on the attenuator switch enables the output to be obtained from a Cathode Follower at an impedance of about 150 ohms. The maximum current obtainable is then limited to 7 mA peak.

Is the price reasonable? This is a very important question, and it might be thought that a generator with all the facilities of the 257 would be expensive. Potential users will therefore be pleased to learn that it costs only £220-0-0.

In instrumentation

Write now for Descriptive leaflet 194A

Airmec *makes most things....better*

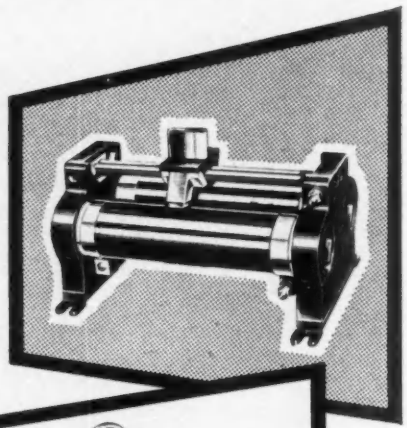
AIRMEC LIMITED · HIGH WYCOMBE · BUCKS Telephone High Wycombe 2501/7

EE 30 122 *for further details*

Better make it Birch

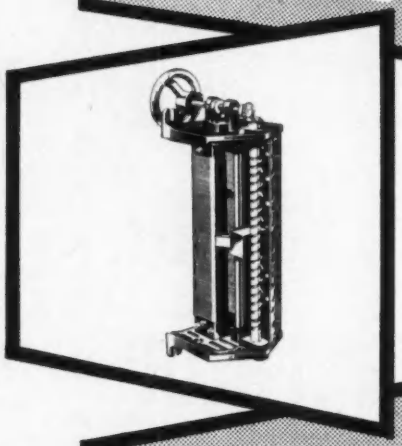
for TUBULAR SLIDING and FIXED RESISTORS

Winding Oxidised Nickel Copper Wire to B.S.115. Brushgear: laminated phosphor bronze brushes in brass diecast holders. Finish: metal parts heavily nickel plated. Write for list No. 110.



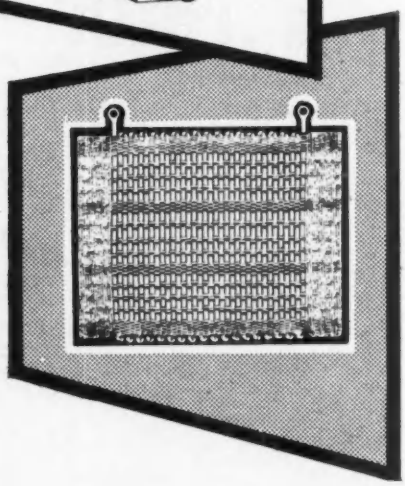
for VARIABLE RESISTORS

Slate wound Resistors of fixed and variable type, incorporating oxidised nickel copper wire to B.S.S.115. Write for list No. 100.



for ASBESTOS WOVEN MATS

Asbestos woven Regulators, loading or heating grids, manufactured in a wide range of sizes to suit customers' particular requirements. End or immediate tappings either lugs or flexible leads. Write for list No. 140.



Birch make it better

REGISTERED TRADE MARK

H. A. BIRCH & CO. LTD. · WOOD STREET, WILLENHALL, STAFFS

Telephone WILLENHALL 494-495 'Grams WILOHM WILLENHALL

LONDON OFFICE: HERGA WORKS, WALLINGFORD, UXBRIDGE, MIDDLESEX Telephone UXbridge 35211

To make the frequency settings as easy as possible the locking system is controlled by two dials. The first dial *A* gives 50 lock-points, every 1Mc/s from zero to 50Mc/s; the second dial *B* gives 100 lock-points every 10kc/s in between the 1Mc/s points of the dial *A*. The third dial *C* of the v.f.o. introduces the above mentioned continuous shift of the lock-points.

To get an absolute crystal-accurate output frequency every 10kc/s the v.f.o. can be switched off. For applications which need a wider continuous frequency variation, the electronic frequency lock of dial *B*, and if necessary from dial *A* as well, can be released to provide a continuous variation of 1Mc/s from the 1Mc/s lock-points of dial *A* only in its 'free' state.

The output frequency of 50kc/s is produced in a carefully designed ring-modulator. The fixed frequency of 105Mc/s is fed in at a low amplitude which is in the linear working range of the modulator, so that any kind of modulation will be reproduced faithfully in the output signal of the ring-modulator.

To utilize all the advantages of the flexibility provided by this heterodyning method the fixed frequency is fed through easily interchangeable plug-in modulation units. So far, modulation plug-in units are available for a.m., s.s.b. and f.m.

The variable-frequency input is at a much higher level, so that the amplitude variations of the variable frequency are not fully reflected in the signal output of the modulator.

To keep the signal output level completely constant independent of frequency- and load-variations, the signal output of the ring-modulator is amplified in a broadband amplifier with automatic output-level control. By this means the output e.m.f. is kept constant at 1V r.m.s. with an accuracy of ±0·1dB. This signal is monitored by a meter with an absolute accuracy of 0·3dB and is available via a 50Ω precision source resistance at the high output socket. A plug-in attenuator with nine 10dB and nine 1dB steps gives a precise attenuation (±0·2dB accuracy) of the 1V output signal, which can be further reduced by a 20dB pad. The stray radiation of the instrument is negligible and permits full use of the lowest output.

Plug-in units are available to extend the range of the instrument up to 500Mc/s.

EE 30 763 *for further details*

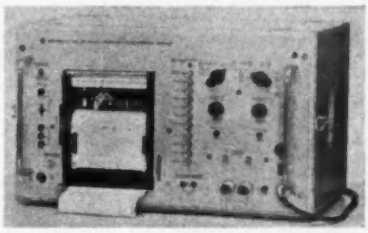
CHART RECORDER

(Illustrated above right)

Distributed by: Aveley Electric Ltd, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex

Aveley Electric Ltd have recently introduced an improved model of the Rohde & Schwarz Enograph D.C. Recorder, a high-speed potentiometric instrument with facilities for linear and logarithmic indication.

The Enograph incorporates many interesting features including a very high input impedance of up to $10^{11}\Omega$, a fully floating input and ten different chart speeds, selected by push-button control. Chart speeds are in the ratio of 2 or 3 to 1, and can be selected from a range of speeds from 10mm/sec up to 20mm/h. Provision is also made for operating the chart from an external drive or alternatively, by press-button switching, the external mechanism can be driven by the Enograph. Remote control of stylus voltage switching and for paper drive is also provided.



The Enograph records all variables which can be represented by direct voltage and the high input impedance permits the direct connexion of circuits such as diode rectifiers, discriminators, photoelectric multipliers, control circuits, valve circuits, etc.

The four types of recording provided (ink, ball-point pen, electrode and stylus) meet practically all of the requirements encountered in recording.

The instrument is particularly suitable for use in test set-ups exposed to vibrations, such as are encountered in aircraft or motor vehicles, since the recording system is extremely rugged.

EE 30 764 *for further details*

STANDARD REFERENCE VOLTAGE

(Illustrated below)

Communications (Air) Ltd, Half Moon Street, Bagshot, Surrey

This mains-operated unit is suitable as a replacement for a standard cell in such applications as the energization of the potentiometer in pen recorders, etc. It provides an output of approximately 1V with a stability comparable to that of a standard cell, but with the advantage that it will supply a somewhat larger current (10mA).

The operating temperature range is −20°C to +55°C and the temperature coefficient ±·001 per cent/°C. The change in output for a 10 per cent change in input is ·001 per cent.

EE 30 765 *for further details*

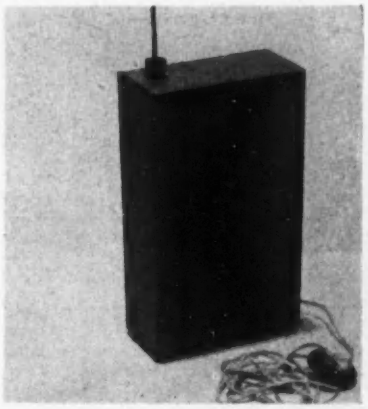
MINIATURE V.H.F. TRANSMITTER

(Illustrated below)

R.E.E. Telecommunications Ltd, Telecomm Works, Market Square, Crewkerne, Somerset

The "Telecomm" v.h.f. transmitter type TT/3 is a completely transistorized miniature instrument for use on one spot frequency within the band 70 to 100Mc/s.

Six transistors are employed in a crystal controlled circuit. An internal mercury cell permits continuous operation for approximately 70 hours. The power output of the transmitter is approximately 25mW depending upon frequency.



The size is 5¼in × 3in × 1¼in and the weight 10oz. A moving-coil microphone is normally supplied, also a quarter wave whip or flexible wire aerial.

A miniature receiver type TR/3 of comparable dimensions employing a double superhet crystal controlled circuit will be very shortly available for use with this transmitter. While both of these instruments are intended for very short range communication on docks, buildings or works sites, tests have been successfully carried out over distances in the region of 5 miles.

EE 30 766 *for further details*

TRANSDUCERS

(Illustrated on page 120)

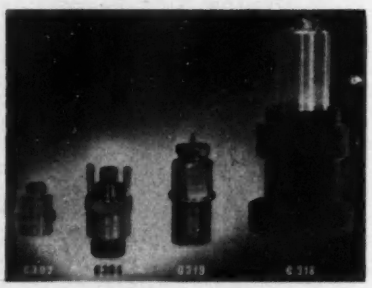
Southern Instruments Ltd, Frimley Road, Camberley, Surrey

The introduction of four new transducers has extended the comprehensive range already available for use with the Southern F.M. System.

The high overload low pressure transducer type G304 is an inductance type

with provision for water cooling. Displacement of the diaphragm is restricted by a stop which enables the transducer to withstand up to 1 000 lb/in². The limit of diaphragm movement, and hence maximum output, is attained at a much lower pressure. This transducer is available with any range between 0 to 10 and 0 to 100 lb/in² and it is suited to applications requiring the measurement of low pressures in a system subjected to high shock pressures. The latter have no effect on the range or zero setting.

The pressure transducer type G302 is an inductance type with a flush diaphragm. This eliminates the dead volume and passage frequency problem which are associated with a transducer having a retracted diaphragm, and allows mounting without modification of the volume of the medium under test. It can be supplied with any range between 0 to 10 and 0 to 10 000 lb/in². Linearity and hysteresis are better than ±1 per cent of full range. An overload of 100 per



cent will not damage the transducer and it will operate at up to 150°C without cooling. It has a high frequency response and can be calibrated statically.

The torsional vibration pick-up type G218 has been improved and is now known as the type G318. There are no slip rings or moving contacts in this inductance type transducer. The new version is more suitable for high speeds and offers greater dependability under conditions of 'run-out' and non-axiality. The output is directly proportional to angular movement in the range ±4°. It can be calibrated under static conditions in the test position using the jig provided.

The pressure transducer type G319 completes the group. It is a capacitance type capable of operating at up to 500°C without cooling.

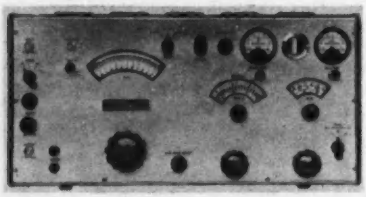
EE 30 767 *for further details*

FREQUENCY METER

(Illustrated above right)

Telemechanics Ltd, Brockenford Lane, Totton, Southampton, Hampshire

This direct reading frequency meter is capable of producing and measuring any discrete frequency between 1kc/s and 3 000Mc/s and has stabilities, depending on the crystal chosen, of 2 parts in 10^{-8} to 4 parts in 10^{-10}. Suitable for driving and checking single sideband systems, exciting nuclear magnetic resonances, single transmission navigation aids, laboratory references for scientific, industrial and educational laboratories, the



instrument has an output capable of driving, and facilities are provided for plugging in an external counter.

The T.D.1 is transportable and the first model incorporates a crystal allowing an accuracy of 2 parts in 10^8 after 1 hour. The internal impedance is 75Ω, output voltage on fundamental frequencies is 100mV, input voltage on fundamental and harmonic frequencies is 1mV and spurious frequency level −80dB. Voltage changes valve deterioration and physical shock effects no appreciable change in frequency or phase.

EE 30 768 *for further details*

MICROWAVE SIGNAL GENERATOR

(Illustrated below)

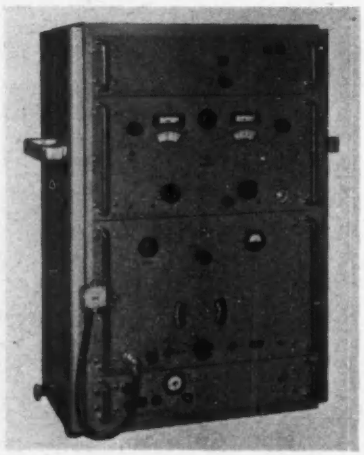
Schomandl K.G., Munich 8, Belfortstrasse, 6-8 Germany

The microwave frequency decade type FD3 forms part of a large range of frequency measuring equipment manufactured by this Company.

The basic frequency standard is produced by a 100kc/s crystal and the output can be locked to this standard at intervals of 100kc/s. Continuous tuning is also provided, the fundamental range being 300Mc/s to 1 000Mc/s with an accuracy of ±300c/s. Harmonics can be produced and extend the range to 12·6Mc/s.

A combination of the FD3, a frequency decade type ND5 and a precision decade type NDF1 provides an increase in accuracy by locking to the standard in 100c/s steps. The incremental error for continuous tuning in the range 300 to 1 000Mc/s is then only ±0·1c/s.

The output power in the fundamental range is 1mW while the sensitivity, when used as a frequency meter is 100μW. Beat indication is provided by head-



phones and 'magic eye' tuning indicator.

EE 30 769 *for further details*

CONTACT ELECTROSTATIC METERS

(Illustrated below)

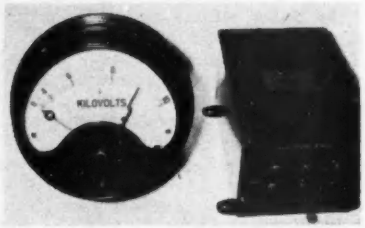
Nalder Bros. & Thompson Ltd, 97 Dalston Lane, London E.8

This new range of instruments has been so designed as to approach more nearly the theoretical performance possible with this type of meter. As a result of the increased torque available it has been possible to produce a range of contact making electrostatic voltmeters.

The instrument contacts, which in the case of over- or undervoltage control can be adjusted externally, are relieved from current carrying by incorporating them in the grid circuit of an associated valve amplifier—the main tripping or alarm current being carried by plug-in solenoid relays.

The operational limits of these instruments are from 100V to 15kV.

The photograph shows a 10kV instrument with contact amplifiers.



EE 30 770 *for further details*

SOLID TANTALUM CAPACITORS

Texas Instruments Ltd, Dallas Road, Bedford

Type SCM "tan-TI-cap" capacitors are available in 203 standard capacitance-voltage combinations ranging from 1 to 330μF ±10 per cent and ±20 per cent tolerance, and in standard voltage classes of 6, 10, 15, 20, 25 and 35V d.c. They are built in four case sizes.

Performance specifications give rated voltage operation at −55°C to +85°C and two-thirds rated voltage at 135°C with stable operation from −80°C to + 125°C. These high performance capacitors are 100 per cent tested for leakage current stability (noise), and are guaranteed to have a failure rate better than 2×10^{-5} when run at maximum rating.

Other features include subminiature industrial standard case sizes, a continuous reverse voltage capability, high vibration and shock resistance and a highly corrosion-resistant finish. Supported axial leads without external seals permit ease of mounting and can be sharply bent without breaking.

These capacitors are of the solid electrolyte, sintered tantalum anode construction which utilizes a tantalum pentoxide dielectric film of high integrity and maximum thickness for each of the voltage classes. This construction ensures that they retain their original characteristics over indefinitely long

periods of shelf life as they can neither leak, dehydrate or be affected by temperature.

EE 30 771 *for further details*

PULSE GENERATOR

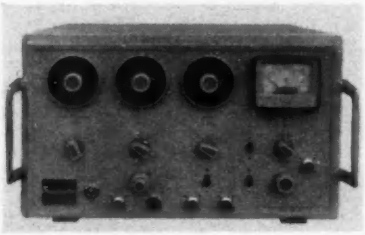
(Illustrated below)

Solartron Laboratory Instruments Ltd., Cox Lane, Chessington, Surrey

The Solartron decade pulse generator GO 1005 is suitable for the accurate determination of transmission characteristics and transient response of amplifiers and networks, or for testing the frequency and amplitude limits of electronic counters. This instrument provides positive or negative going, single or double rectangular pulses of up to 100V amplitude at repetition rates from 10c/s to 1Mc/s.

Three sets of concentric decade controls, with illuminated dials, permit coarse and fine adjustments of pulse duration, repetition rates and signal delay; with the aid of the built-in amplitude monitoring meter output requirements may be set up with ease and accuracy.

Signal delay time, relative to a 10V pre-pulse output, is variable over the



same range as the rectangular pulse duration viz. 250mμsec to 100msec.

In the double-pulse mode of operation the leading edge of the first rectangular pulse coincides with the pre-pulse and the leading edge of the second identical rectangular pulse occurs after the set signal delay.

A delayed-pre-pulse is also made available approximately 250mμsec after the pre-pulse, thus providing a trigger output which may be made to coincide exactly with the leading edge of the main rectangular pulse.

EE 30 772 *for further details*

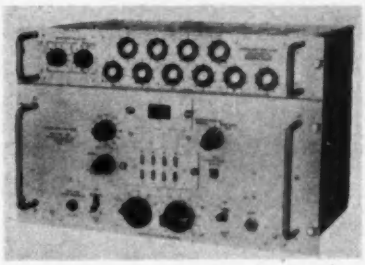
TIMING UNIT

(Illustrated above right)

Dynatron Radio Ltd, Maidenhead, Berkshire

This timing unit has been designed primarily to operate with the 1009 series of scaling units from which it can obtain its supplies. The main function of the unit is to switch the scaling unit off at either a pre-set time or a pre-set number of counts and to enable the count and time totals to be read from calibrated decade counting tubes.

The N108 has a maximum time store of 100 000sec and when used in conjunction with the scaler, a maximum count of 1 000 000 counts. A further advantage of the N108 is that it enables the scaler to be operated at its maximum resolu-



tion time of 1μsec thereby allowing the maximum counting rate of the scaler to be utilized.

The illustration shows the timing unit fitted to the type 1009E scaling unit.

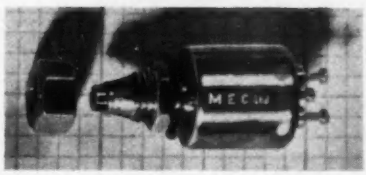
EE 30 773 *for further details*

MINIATURE POTENTIOMETER

(Illustrated below)

Miniature Electronic Components Ltd, The Lye, St. Johns, Woking, Surrey

This single turn miniature wirewound precision potentiometer is manufactured under licence from Technology Instrument Corporation of America and has been specially developed for use in aircraft and guided missiles.



The maximum diameter is 0·5in and the overall length 1·14in.

It is capable of dissipating 1·5W at 80°C, has a temperature range of −55 to +150°C and is available in ten standard values from 50Ω to 50kΩ.

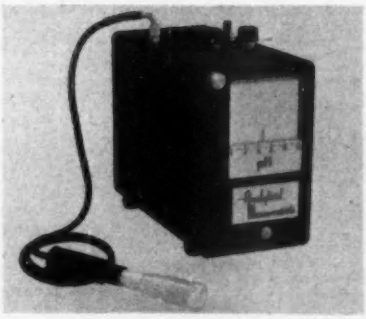
EE 30 774 *for further details*

RECORDING pH METER

(Illustrated below)

Analytical Measurements Ltd, Dome Buildings, The Quadrant, Richmond, Surrey

This instrument utilizes an electronically modulated amplifier that compensates for mains voltage fluctuations and uses standard valves. A strip chart recorder forms the front panel of the instrument and contains a 63ft roll of chart paper that will last for 31 days at 1in/h. Other chart speeds are available



up to 16in/h by a simple gear change. A pressure sensitive coating is used on the chart paper. Connexions for insertion of a platinum resistance thermometer provide automatic temperature compensation. A switch on the front panel permits disconnexion of the chart drive so that the instrument becomes an indicating pH meter. The analytical pH probe unit provides a unitory glass electrode system completely protected by polyethylene.

EE 30 775 *for further details*

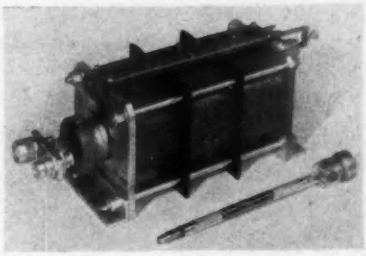
MICROWAVE VALVES

(Illustrated below)

Standard Telephones & Cables Ltd, Connaught House, Aldwych, London W.C. 2

The addition of two new H-wave oscillator tubes to the existing range now enables the frequency band from 5850 to 7770Mc/s to be covered with four tubes. These tubes each have an electronic tuning range of ±8·5Mc/s and a minimum output of 800mW. They have excellent frequency stability, low operating voltage and adequate cooling by radiation only.

The tubes are types V261C/1M (5850



to 6350Mc/s) and V266C/1M (6350 to 6850Mc/s).

A fifth tube of the H-wave type, V265A/1M, is only mechanically tunable, and has a minimum output of 200mW over the range 5850 to 7100Mc/s.

A new velocity modulated oscillator tube of the coaxial line type, known as the V231C/1K, is intended primarily for use in S-band radar. The tube covers the frequency range 3060 to 3180Mc/s, with a minimum power output of 40mW. It is intended for use in a cavity type 495-LVA-252 which is a compact unit with a waveguide type WG10 output. If required, this tube can be tuned electronically over a range of at least ±8Mc/s.

The travelling wave limiter tube type W9/BE, which is illustrated, covers the frequency band 2500 to 4100Mc/s, has a low-level gain of 15 ±3dB and a saturated power output of −7 to −13dBm. The tube is intended for overload protection in equipment where a very wide range of input power is anticipated and also provides useful gain at low input levels.

An aluminium foil focusing solenoid is available (type 495-LVA-007) which incorporates coaxial r.f. input and output connexions.

EE 30 776 *for further details*

Meetings this Month

THE BRITISH INSTITUTION OF RADIO ENGINEERS

Radar Group
Date: 1 February. Time: 5.30 p.m.
Held at: London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, W.C.1.
Lecture: A Fast Electronically Scanned Receiving System.
By: D. E. N. Davies.

Computer Group
Date: 8 February. Time: 5.30 p.m.
Held at: London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, W.C.1.
Lecture: Perseus, a Medium-scale Data Processing System.
By: G. Emery.

Electro-Acoustics Group
Date: 14 February. Time: 5.30 p.m.
Held at: London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, W.C.1.
Lecture: Some Phycho-Acoustic and Engineering Aspects of Hearing Aid Design.
By: J. Jessop.

South Midlands Section
Date: 24 February. Time: 7 p.m.
Held at: North Gloucestershire Technical College, Cheltenham.
Lecture: Design Aspects and Characteristics of Long Distance Waveguide Communication Systems.
By: A. E. Karbowiak.

Southern Section
Date: 22 February. Time: 7 p.m.
Held at: Lanchester Building, University of Southampton.
Lecture: The Application of Computers to Commercial Problems.
By: N. D. Hill.

THE INSTITUTION OF ELECTRICAL ENGINEERING

All meetings will be held at Savoy Place, commencing at 5.30 p.m. unless otherwise stated.

Supply Section
Date: 1 February.
Lecture: The Protection of High-Voltage Insulators from Power-Arc Damage.
By: A. E. Guile.
Date: 15 February.
Lecture: A General Theory of Depreciation of Engineering Plant.
By: D. Rudd.

Ordinary Meeting
Date: 2 February.
Lecture: Silicon Power Rectifiers.
By: A. J. Blundell, A. E. Garside, R. G. Hiberd and I. Williams.

Medical Electronics Discussion Group
Date: 3 February.
Discussion: Recent Technical Developments in Eye Movement Recording.
Opened by: P. A. Merton and C. Rashbass.

Measurement and Electronics Section
Date: 8 February.
Lecture: Magnetic Properties of Thin Films for Computing Devices.
By: E. M. Bradley.

Utilization Section
Date: 9 February.
Lecture: Some Notes of the Electrical Requirements of General Cargo Docks.
By: E. R. Radway.

Electronic and Communication Section
Date: 17 February.
Lecture: A Comprehensive Introduction to Plasma Physics.
By: W. B. Thompson.
Date: 22 February.
Lecture: Coding Theory and its Applications.
By: J. M. Meggitt.

Measurement and Supply Utilization Sections
Date: 21 February.
Lecture: Sphere-Gaps.
By: E. Kuffel.

THE INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Date: 1 February. Time: 5 p.m.
Held at: Conference Room, Waterloo Bridge House, S.E.1.
Lecture: The Gas Pressurisation of Telephone Cables.
By: H. B. Cooper and R. A. M. Light.
Date: 14 February. Time: 5 p.m.
Held at: Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2.
Lecture: The First Four Years of Transatlantic Cable Telephony.
By: J. F. Brampton and D. M. Gambier.

THE PLASTICS INSTITUTE

Date: 6 February. Time: 6.45 p.m.
Held at: Grand Hotel, Leicester.
Lecture: Vacuum Forming Coupled to Extrusion.
By: A. M. Henry.
Date: 7 February. Time: 6.30 p.m.
Held at: Wellcome Building, Euston Road, London, N.W.1.
Lecture: The French Plastics Industry.
By: Professor L. Jacqué.

THE SOCIETY OF ENVIRONMENTAL ENGINEERS

Date: 15 February. Time: 6 p.m.
Held at: Imperial College, London.
Lecture: The Development and Testing of Small Electronic Components.

THE SOCIETY OF INSTRUMENT TECHNOLOGY

Data Processing Section
Date: 6 February. Time: 7 p.m.
Held at: Manson House, 26 Portland Place, London, W.1.
Lecture: The Universal Decision Element.
By: Professor J. E. Parton and A. Rose.
Date: 28 February. Time: 7 p.m.
Held at: Manson House, 26 Portland Place, London, W.1.
Lecture: Three Terminal Bridge Measurements and Automation.
By: Dr. V. S. Griffiths.

Cheltenham Section
Date: 9 February. Time: 7.30 p.m.
Held at: Belle Vue Hotel, Cheltenham.
Lecture: Instrumentation at Berkeley Power Station.
By: F. J. Benstead.

THE TELEVISION SOCIETY

Date: 10 February. Time: 7 p.m.
Held at: The Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2.
Lecture: Transistorized Distribution Amplifiers.
By: B. Marsden.
Date: 23 February. Time: 7 p.m.
Held at: The Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2.
Lecture: Programme Problems and Possibilities Associated with 'Monitor'.
By: H. Wheldon.

PUBLICATIONS RECEIVED

THE REACTANCE SLIDE RULE made by Shure Bros. of Illinois, U.S.A., is now available in the U.K. from J. W. Maunder of 22 Orchard Street, London, W.1, price 12s. 6d. post free. The slide rule can be used for resonant frequency capacitive reactance, inductive reactance, "Q" and dissipation problems in a frequency range from 5c/s to 10 000Mc/s.

A GUIDE TO INFORMATION ON ATOMIC ENERGY IN BRITAIN is a catalogue containing a selected list of British books, periodicals, reports, films, photographs and display material which was originally compiled for specialized and prestige distribution overseas. It is felt however that the range of information covered would be of assistance to individuals, libraries and organizations in the United Kingdom and it has therefore been made available through H.M. Stationery Office, London, price 5s.

TRANSPORT ELECTRONIC NEWS is a new booklet which has been produced by the Research Department of the British Transport Commission and it is being circulated by the Chief of Research, BTC, 222 Marlebone Road, London, N.W.1.

THE THIRD ANNUAL REPORT of the National Institute for Research in Nuclear Science for the period 1 April, 1959 to 31 March, 1960 has now been published. Information is available from United Kingdom Atomic Energy Authority, 11 Charles II Street, London, S.W.1.

PRECISION TIMERS is a catalogue of the instruments manufactured by The Standard Electric Time Company for accurately measuring elapsed time. These timers are used in laboratory, testing and production work in industrial and commercial plants, governmental agencies, educational institutions and wherever close timing is needed. Copies of this catalogue can be obtained from Leonard Wadsworth and Co. Ltd, Bank Buildings, 47 Wimbledon Hill Road, London, S.W.19.

THE ULTRASONOSCOPE Mk. 2 is a catalogue designed not only to set out the comprehensive range of equipment available from the Ultrasonoscope Company, but also to be a fundamental reference book for the newcomer to the field of ultrasonic non-destructive testing. More than half the book is devoted to the basic principles of ultrasonic testing and descriptions of some of the techniques used for the more common applications. Further information is available from Mr. K. Bennett, Ultrasonoscope Co. (London) Ltd, Sudbourne Road, Brixton Hill, London, S.W.2.

CAREERS IN GOVERNMENT, INDUSTRY AND COMMERCE is a new periodical launched this year and will be published each mid-term hereafter. It presents the 400 or so companies and organizations who welcome employment enquiries from specifically qualified men and women about to choose a career. The companies are classified under the occupation opportunities they offer and occupation headings and entries are listed alphabetically. Copies are available price 1s. 6d. and further information can be obtained from Polyphon Public Relations Ltd, Ludgate House, Fleet Street, London, E.C.4.

DESIGNERS' HANDBOOK is a publication which has been prepared as an initial guide to printed circuit design. It is based on the experience of the design and production staff of Tectonic Industrial Printers Ltd, Denmark Street, Wokingham, Berkshire, from whom copies are available.

THE TRAINING OF GRADUATES is a revised edition of the Report authorized for publication by the Council of The Institution of Electrical Engineers. It has been prepared by the Joint Committee on Practical Training in the Electrical Engineering Industry, which is broadly representative of the varied organizations in the power and electronic branches of the industry. The Report reaffirms the belief in the three-point plan of basic workshop training, general mechanical and electrical training and directed objective training and an endeavour has also been made to outline the underlying purpose of the training period in the broader sense. Copies of the Report may be obtained on application to the Secretary of the Institution, Savoy Place, London, W.C.2, price 2s. 6d., post free.

COMPUTER ABSTRACTS together with 'Computer News' is published each month, the former contains information on computers and computation and may be used for current scanning and for reference purposes, while the latter deals mainly with trade literature and announcements of exhibitions and conferences. A subscription can be obtained from the Technical Information Company Ltd, Chancery House, Chancery Lane, London, W.C.2. Price £25 4s. per annum.

C. F. CASELA and Co. Ltd have published a 150th Anniversary Brochure which gives briefly the history and illustrates instruments from the range available from the company. Copies are available from the company at the following address: Regent Street, Fitzroy Square, London, W.1.

DAVIS AND TIMMINS have produced a comprehensive and informative price list in respect of fasteners turned from the bar, i.e. cut thread screws, nuts, etc. Copies of the price list are available upon request from the Sales Director, Davis and Timmins Ltd, Billet Road, Walthamstow, London, E.17.

The whole of Continental Connectors' UK production is now concentrated on Greenford. Production is rapidly growing, to keep pace with increasing demand. Continental's research and development engineers are well under way, shaping present and future production to the needs of modern industry.

Two recent events worthy of note are the adoption of the 0·1 and 0·2 inch pitch standards and the introduction of a new eight-way test-point connector.

Keep an eye on Continental

A full range of leaflets will be sent to you on request

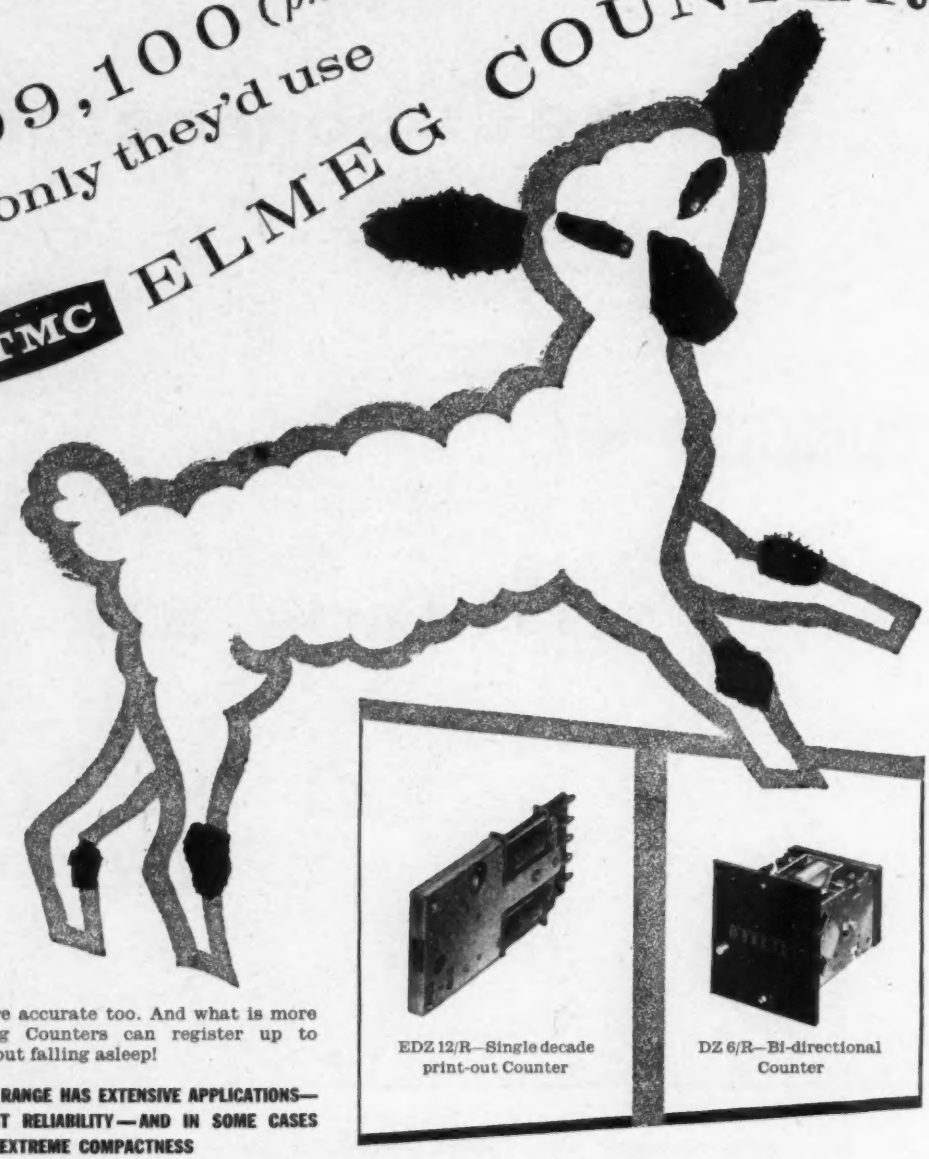
Continental Connectors

CONTINENTAL CONNECTORS LIMITED

Associated with the Ultra Group of Companies

Continental Connectors Ltd · Industrial Estate · Long Drive · Greenford · Middlesex · WAXlow 5721-7

... 99,100 (*phew!*) if only they'd use TMC ELMEG COUNTERS



So much more accurate too. And what is more —TMC Elmeg Counters can register up to 9,999,999 without falling asleep!

THE VERSATILE RANGE HAS EXTENSIVE APPLICATIONS— OFFERS UTMOST RELIABILITY—AND IN SOME CASES EXTREME COMPACTNESS

Available in "Print-out" and "Read-out" form, Elmeg Counters have fast operating speeds, some up to 40 per second. A number operate on up to 240 volts, with uni-directional or bi-directional motions. Re-setting to zero by electrical, mechanical or electro-mechanical methods. There are auxiliary contacts operating on each revolution of a numbered wheel. The range includes counters for flush panel mounting and surface mounting. *No special servicing is required.*

EDZ 12/R—Single decade print-out Counter

DZ 6/R—Bi-directional Counter

The number of applications for which the wide range of TMC Elmeg Counters can be used to advantage are far too many to list in detail. The following will act as a general guide:

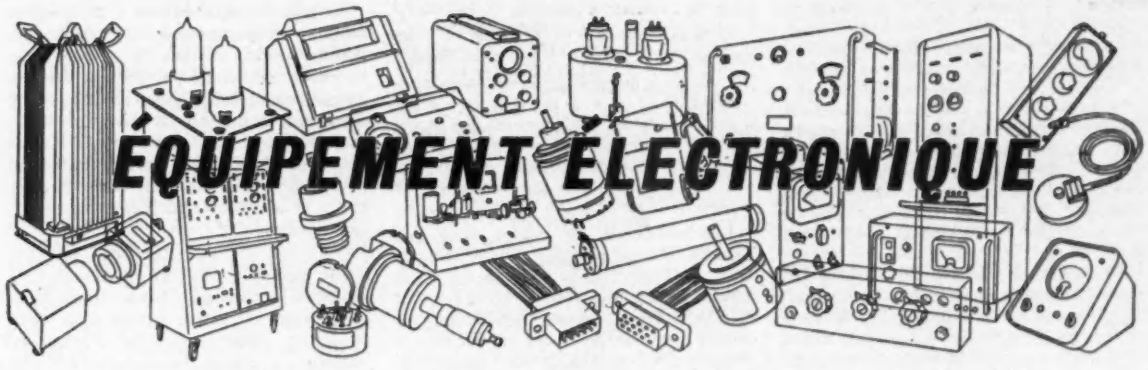
- In conjunction with proximity switches of photocell equipment on production flow lines.
- In factory process control.
- In computers and office accounting machines.
- In factory statistical equipment.

A letter or telephone call will put us at your service.

Telephone Manufacturing Company Limited

Relay Division B, Hollingsworth Works, London SE21

Telephone: GIPsy Hill 2211



ÉQUIPEMENT ÉLECTRONIQUE

Une description basée sur des renseignements fournis par les fabricants de nouveaux organes, accessoires et instruments d'essai

Traduction des pages 116 à 121

MICROVOLTMÈTRE SÉLECTIF

Distribué par Aveley Electric Ltd, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex

(Illustration à la page 116)

Le "Selektomat" type USWV fabriqué par Rohde & Schwarz est un récepteur à changement de fréquence utilisant un oscillateur local électriquement accordé. Quoique principalement conçu pour servir d'instrument d'appoint au "Polyskop," il peut être employé avec n'importe quel générateur de signaux, classique ou de balayage, fonctionnant dans la gamme de fréquences utilisée.

La gamme de fréquences de 30 à 400 MHz est sub-divisée en sept gammes et l'accord peut être effectué manuellement ou automatiquement, les circuits de repérage étant "verrouillés" à la fréquence choisie qui est introduite dans l'entrée.

L'entrée minimum est de 10μV efficaces; la réponse de fréquence est de 0.2%àMHz ± 1dB et l'atténuation d'entrée est de 0 à 60 dB. La largeur de bande est de 125kMz (3dB) et 1 MHz (80 dB vers le bas). L'indication logarithmique est de 0 à 80dB, tandis que l'indication linéaire est de 0 à 20dB avec l'atténuateur supplémentaire de 60dB.

Le "Selektomat" est idéal pour la mesure de réponse de fréquence sur circuits à 2 ou 4 bornes, tels que filtres, amplificateurs et atténuateurs, ainsi que pour la mesure de la réflexion d'entrée sur circuits à 4 bornes et du coefficient de réflexion sur antennes à réflectomètres, etc.

EE 30 751 *pour plus amples renseignements*

SOURCE DE SIGNAUX SHF (FRÉQUENCES SUPÉRIEURES)

Distributeurs: Livingstone Laboratories Ltd, Retcar Street, London N.19

(Illustration à la page 116)

La Société Hewlett-Packard a mis au point un système générateur de puissance à large bande aux fréquences micro-ondes. La gamme de fréquences de 18 à 40 kMHz est couverte par deux doubleurs de fréquences, types 938A et 940A. Le modèle 938A fournit une puissance de 18 à 26,5 kMHz lorsqu'il est actionné par une source de 9 à 13,25 kMHz, quant au modèle 940A, il fournit une puissance de 26,5 à 40 kMHz lorsqu'il est actionné par une source de 13,25 à 20 kMHz.

Les doubleurs de fréquences se composent essentiellement de générateurs d'harmoniques à cristal à large bande montés de façon appropriée dans des guides d'ondes. Les doubleurs incorporent également un contrôleur de puissance et un atténuateur de précision. Les deux doubleurs peuvent être entraînés par klystrons, générateurs de signaux ou oscillateurs de balayage. Etant donné que les deux modèles 938A et 940A sont des instruments à large bande, le signal d'entrée peutêtre soit à ondes entretenues, soit à impulsions, soit de balayage. Le signal de sortie retient donc les avantages de la source d'entraînement.

Les deux doubleurs de fréquences ont des contrôleurs de puissance incorporés et des atténuateurs à ailettes rotatives de précision qui permettent un réglage de niveau précis de 0 à −100 dB avec une précision de niveau absolue de ±1 dB pour la plupart des fréquences. La précision de l'atténuateur différentiel est de 2% de la lecture ou ±0,2 dB, selon la valeur qui est la plus élevée, tandis que le rapport d'amplitude de tension (d'ondes stationnaires) de sortie est de l'ordre de 2 : 1 à une sortie maximum, et il est inférieur à 1.2 : 1 lorsque l'atténuateur est fixé à −10 dB ou davantage.

Un chiffre caractéristique d'efficacité de conversion est celui de 16 dB pour une entrée de 10 mW.

EE 30 752 *pour plus amples renseignements*

ELECTRONIC ENGINEERING
occupera un stand au
SALON INTERNATIONAL DES COMPOSANTS ÉLECTRONIQUES
qui se tiendra à Paris du 17 au 21 février 1961. Les visiteurs seront les bienvenus.

BLOCS D'ALIMENTATION EN COURANT CONTINU STABILISÉ

Claude Lyons Ltd, Valley Works, Hoddesdon, Hertfordshire

(Illustration à la page 116)

Cette nouvelle gamme de blocs d'alimentation en courant continu stabilisé est étudiée pour l'incorporation au matériel particulier d'un fabricant.

Le bloc se compose d'une alimentation en courant continu conventionnelle (transformateur abaisseur, redresseur en pont et condensateur de filtrage) dont l'entrée est injectée par transducteur. Un amplificateur à réaction transistorisé mesure la tension de sortie à partir de l'alimentation et règle continuellement le courant continu dans l'enroulement de commande du transducteur de façon à mantenir constante la tension de sortie dans une gamme étendue de variations de tension et de fréquence d'entrée (secteur) et de courant de sortie (charge).

L'alimentation est sans lampes et elle est des plus sûres. Le facteur d'ondulation est faible, c'est à dire de l'ordre de 1%. La tension de sortie est réglable dans une gamme de ±15% par rapport à la valeur nominale. Enfin, un haut degré de protection est assuré contre les court-circuits.

Les modèles existants jusqu'ici ont les puissances de sortie suivantes: 12V à 8VA, 20V à 5A, 24V à 4A, 32V à 3A et 48V à 2A.

[**EE 30 753** *pour plus amples renseignements*

LIGNE DE RETARD VARIABLE À MAGNÉTOSTRICTION

Ferranti Ltd, Hollinwood, Lancashire

(Illustration à la page 116)

Les lignes de transmission à retard à magnétostriction dans lesquelles les impulsions mécaniques sont transmises le long de fils métalliques, sont employées depuis quelques années pour l'emmagasinage et l'action différée dans les calculateurs, les simulateurs et autres systèmes électroniques. Ce n'est que dernièrement que la technique assurant une variation continue de l'action temporisée a été suffisamment mise au point pour per-

mettre la fabrication d'un article de toute sécurité.

La société Ferranti Electric Inc., de New York, a donc récemment mis sur le marché une ligne de retard variable à magnétostriction, avec retards variables dans la gamme de 2 μsec à 10 msec. La vitesse de numérotation de la ligne va jusqu'à 500 kHz et la fluctuation de retard est inférieure à 1 mμsec. Les réglages de retards sont linéaires et reproduisibles à un degré de précision de 0,1%.

La variation continue de retard se fait par commande mécanique, au moyen d'une gorge de roulement des billes à circulation renouvelée et à couple réduit, se prêtant au fonctionnement manuel ou par servo-mécanisme. Les microrupteurs fournissent une indication électrique des limites de variation tandis que les butées d'arrêt mécaniques empêchent la surmultiplication de vitesse.

EE 30 754 *pour plus amples renseignements*

CONNECTEUR DE THERMO-COUPLE

West Instruments Ltd, Regent Street, Brighton, Sussex

(Illustration à la page 117)

Cette fiche de thermocouple est étanche à l'eau et à l'huile er serait en mesure d'éliminer les erreurs se produisant souvent au point de jonction avec un câblage prolongateur.

Elle se prête comme prise d'extrémité de thermocouples de facon à ce qu'une connexion rapide et aisée puisse être effectuée à un fil d'amenée prolongateur. Les thermocouples peuvent être remplacés sans déranger ce qui pourrait être une ligne coûteuse de fil plombé. Elle rend également inutile les réglettes de raccordement et autres types de connecteurs pouvant produire des erreurs par suite de vibrations, de poussières et d'autres facteurs.

Les broches et les prises du connecteur sont faites de matériaux choisis afin d'empêcher des charges parasites de force électromotrice dues aux gradients de température dans la fiche et la prise. Les connecteurs sont aussi polarisés afin d'éviter les raccordements défectueux.

EE 30 755 *pour plus amples renseignements*

CALCULATEUR ANALOGIQUE MOBILE

Telefunken, GmbH, Berlin, Charlottenberg, 1

(Illustration à la page 117)

Le calculateur analogique mobile, type RAT 700, est un appareil à courant continu entièrement transistorisé. Il est constitué de sous-éléments qui permettent l'assemblage d'un matériel de calcul analogique de n'importe quelle grandeur et de n'importe quelle capacité, des monoblocs de calcul individuels jusqu'aux grande installations de calcul.

Plusieurs calculateurs peuvent être reliés en parallèle et la télécommande est également possible. L'oscilloscope de sortie OMS a été spécialement réalisé pour le calculateur mobile.

Chaque calculateur Type RAT 700 contient les éléments suivants au choix:

10 à 15 amplificateurs de fonctionnement, dont 6 à 8 peuvent etre commutés, comme intégrateuràsommateur; 4 à 7 comme sommateur; 0 à 4 multiplicateurs; 20 potentiomètres (2 types); 2 à 20 générateurs de fonctions; 8 diodes; 0 à2 relais.

Des résistances de calcul, ainsi que deux condensateurs pour chaque intégrateur, sont incorporés à l'appareil. Les amplificateurs de fonctionnement sont stabilisés au découpeur périodique de façon que, en plus des opérations à répétition et uniques, des calculs de longue durée puissent aussi être effectués.

L'usage exclusif de transistors assure une grande sécurité de fonctionnement. L'appareil est relativement léger, ne pesant que 80 kg. cependant que sa faible consommation électrique (90 VA) rend superflu tout système de climatisation ou d'aération.

EE 30 756 *pour plus amples renseignements*

MAGNÉTOPHONE DE BORD

Sir W. G. Armstrong Whitworth Aircraft Ltd, Baginton, Nr. Coventry, Warwickshire

(Illustration à la page 117)

Ce magnétophone de bord a été réalisé à l'origine pour l'utilisation dans des engins lancés à partir du champ de lancement de fusées de Woomera (Australie).

Une fréquence porteuse de 50 kHz est enregistrée jusqu'au niveau de saturation, tant dans la direction positive que dans la direction négative sur 3 ou 7 pistes de 0,63 cm et de 1,27 cm de bande magnétique passant devant les têtes enregistreuses à 190,5 cm/sec. Les renseignements enregistrés sont utilisés pour moduler en fréquence la porteuse entre les limites de 35 et 65 kHz, avec une fréquence de déviation de ±15 kHz. La quatrième ou huitième piste est employée pour enregistrer un signal de référence de 100 kHz piloté par quartz servant à la fois à mesurer, au cours du réenregistrement, la fréquence des canaux de renseignements, en tant que sous-multiple de sa propre fréquence, et à assurer le minutage de temps écoulé. Par conséquent, la précision de la mesure de fréquence est contrôlée par le signal de référence et non pas par la vitesse du ruban magnétique, quoiqu'il soit nécessaire de maintenir cette dernière dans des limites assez serrées. Les pistes modulées en fréquence, dont il y a trois sur la bande de 0,63 cm et sept sur la bande de 1,27 cm, sont désignées comme "pistes de données." La quatrième ou huitième piste respectivement, s'appelle la "piste de référence" et elle sert également à enregistrer un "marqueur de temps zéro," afin d'identifier le début de l'enregistrement des renseignements ou du minutage de temps écoulé.

Le pont du magnétophone est d'aspect assez classique, consistant en une bobine d'alimentation chargée à friction, un cabestan commandé par moteur entraînant la bande magnétique devant la tête d'enregistrement au moyen de roues entraîneuses en caoutchouc et de rouleaux d'acier. Les roues entraîneuses sont embrayées par une came excentrique et une bobine enrouleuse actionnée par un moteur c.c. à part. La vitesse du moteur de cabestan principal est contrôlée par un coffret de commande électronique de l'alimentation de champ dont la puissance d'entrée dérive d'un commutateur d'impulsions sur l'arbre du moteur. La vitesse du moteur d'enroulement n'est contrôlée que par la tension de la bande.

Les bobines de bandes magnétiques sont fabriquées spécialement pour pouvoir résister aux accélérations de vol et aux forces vibratoires, ainsi que pour contribuer à la protection de la bande contre les chocs. Ces derniers sont principalement amortis par le pont du magnétophone et son couvercle qui sont tous deux en acier à haute résistance.

Les moteurs en saillie sur le pont et les circuits électroniques entièrement transistorisés sont logés dans un léger coffret en acier fixé à la base du pont d'enregistrement. Tous ces éléments peuvent se détacher complètement sous un choc et sont considérés comme non-récupérables. Des vitesses de choc d'environ 120 m/sec sur terre et sur matériaux solidement tassés, et des ralentissements allant de 2500 a 3500 g ont été soutenus par ces magnétophones dont les bandes ont été retrouvées en parfait état.

EE 30 757 *pour plus amples renseignements*

FOUR À COUPLE THERMOÉLECTRIQUE

George Kelk Ltd, 5 Lesmill Road, Don Mills, Ontario, Canada

(Illustration à la page 117)

La susdite société fabrique un four à couple thermoélectrique de référence pouvant loger des jonctions de référence pour un nombre de thermocouples de mesure pouvant aller jusqu'a 48 pièces de divers types ,et pesant moins de 3,628 kg. L' emploi d'une jonction à part pour chaque thermocouple élimine les erreurs résultant des thermocouples à la masse.

La température des jonctions de référence est maintenue constante à 0,5% près pour une gamme étendue de températures ambiantes.

Des connecteurs appropriés en alliage pour thermocouples individuels sont fournis pour la connexion aux thermocouples extérieurs avec connecteurs multiples pour les circuits de sortie. Le four peut être fourni pour le fonctionnement sur courant alternatif ou sur courant continu.

EE 30 758 *pour plus amples renseignements*

PONTS À FAIBLE RÉSISTANCE

Startronic Ltd, 117a Malden Road, New Malden, Surrey

(Illustration à la page 118)

Le pont de mesure à faible résistance modèle 10° est un instrument couvrant un gamme de 0,05 ohms à 50 kiloohms en cinq gammes à double décade, avec une précision de 0,5%. Les dimensions de sa base sont de 12,7 × 19 cm, avec un panneau à pente, allant de 10,1 cm de haut à l'arrière à 5 cm à l'avant afin d'en faciliter l'usage. Il est entrainé par batterie intérieure à pleine charge de 4,5 V.

Le cadran gradué a 10,1 cm de diamètre et l'indication de zéro se fait au moyen d'un appareil de mesure à cadre mobile de qualité supérieure et doté d'une échelle à miroir. Les résistances courantes utilisées sont supérieures à 0,1%.

L'instrument peut être livré également avec gammes à une décade, donnant une zone d'action totale de 0,05 ohms à 5 kiloohms, l'une ou l'autre version étant aussi parfaitement propre à la vérification intérieure des marchandises, au contrôle de fabrication ou aux travaux de laboratoire.

Il existe, de même, deux variantes de l'instrument, soit le modèle 108 et le modèle 110, tous deux renfermés dans le même type de boîtier.

Le modele 108 a une gamme unique de 0 à 160 mégohms, avec une précision de ±1 mégohm ou ±2%, selon la partie de l'échelle utilisée. Les mesures peuvent être effectuées avec un courant de 0,1 A, 0,2 A, 0,3 A ou 0,6 A traversant la résistance que l'on mesure. On peut aussi effectuer la mesure directe à l'extrémité de connexions d'essai ayant une résistance totale de 10 mégohms. L'instrument peut être employé, d'autre part, pour mesurer la résistance de contact ét de liaison métallique.

Le modèle 110 est un pont de comparaison étalonné directement à ±10%, avec des cosses pour étalons extérieurs et offrant la possibilité d'avoir jusqu'à quatre étalons intérieurs sur demande spécifique. L'échelle est étalonnée en plots de 0,1% jusqu'à 1%, et en plots de 0,5% allant de 1% à 10%. La précision de l'étalonnage est de 0,1% jusqu'à 5%, et de 0,2% entre 5% et 10%, la gamme étant de 5 ohms à 10 kiloohms.

EE 30 759 *pour plus amples renseignements*

PHOTOTRANSISTOR "SERVO-POT"

Sangamo Weston Ltd, St. George's Court, 22-26 New Oxford Street, London W.C.1

(Illustration à la page 118)

Ce dispositif est, fondamentalement, un amplificateur de tension continue utilisant un phototransistor et un galvanomètre dans un circuit en pont étudié pour produire une sortie de courant directement proportionnelle à l'entrée en millivolts. Un des avantages de ce type de circuit est qu'aucun courant appréciable n'est tiré de la source d'entrée.

Le "Servo-Pot" a été prévu pour une alimentation de 24 volts c.c. et pour fournir une puissance de sortie ordinaire de 1mA pour une entrée de 10mV. La base du dispositif comporte une prise de courant et le boîtier mesure à peu près 76mm de long sur 30 mm de diamètre.

EE 30 760 *pour plus amples renseignements*

HORLOGE À INDICATIONS NUMÉRIQUES

Microcell Electronics Ltd, Blackwater, Camberley, Surrey

(Illustration à la page 118)

Cet appareil a été réalisé pour être utilisé avec le système de balayage d'alarme à concentration de données Microcell type 300, et il s'adapte à un bâti de 482 mm. Il est également fourni sous forme d'instrument indépendant.

La fréquence d'entraînement de base, soit 50 Hz, est obtenue du secteur et elle est divisée en étages de transistor jusqu'à 1 Hz. La division de fréquence ultérieure s'effectue sur unisélecteurs interchangeables miniature, pour l'indication des heures, des minutes et des secondes.

Un indicateur numérique à six décades donne le temps sous forme d'heures, de minutes et de secondes et le débit est fourni sur 6 des 45 lignes pour actionner un dispositif imprimeur.

Des intervalles de temps mis en programme et donnant une fermeture de contact ou une impulsion de tension peuvent être établis toutes les 2, 5, 10, 20, 30 ou 60 minutes, par le choix du commutateur approprié. De plus, la même fermeture de contact ou impulsion de tension peuvent être donnés à intervalles horaires précis en plaçant simplement une broche dans un tableau à broches miniature de 24 positions, par exemple des temps caractéristiques mis en programme tels que 0000, 0600, 0800, 1100, 1500, 1800 peuvent être établis.

EE 30 761 *pour plus amples renseignements*

TRANSFORMATEURS MOYENNE FRÉQUENCE MINIATURE

The Wireless Telephone Co. Ltd, Vicarage Lane, Ilford, Essex

(Illustration à la page 118)

La Wireless Telephone Company Ltd, une filiale du groupe des Sociétés Plessey, vient de présenter une nouvelle série de transformateurs passe-bande miniature à moyenne fréquence. Ils sont prévus pour les récepteurs transistorisés portatifs à fréquences moyennes dans la gamme de 450 à 480 kHz. Ces nouveaux transformateurs se distinguent en particulier par le montage parallèle des bobines, ce qui assure un couplage stable et un assemblage compact.

Les noyaux de ferrite sont sous moulage de résine d'époxyde afin d'assurer une bonne rigidité mécanique, de même que la résistance aux vibrations. Les dimensions de l'enveloppe ont été réduites à 27 × 16 × 17,5 mm de haut.

Des transformateurs à accord double sont utilisés dans les deux premiers étages et un élément à accord simple est utilisé dans le troisième étage. L'alignement fréquence moyenne se fait par noyaux à fer divisé réglables. Ces derniers sont montés de façon inédite: à la place du noyau normal fileté, un noyau lisse est aggloméré à une vis au polystyrène s'insinuant dans un trou fileté du mandrin de bobine. Ceci assure une robuste vis de réglage pouvant être utilisée par des tourne-vis à lames métalliques de conception courante. Cette réalisation permet en outre de sceller à la cire les noyaux, après ébavurage final.

La diode et le condensateur HF de découplage du transformateur du troisième étage sont fixés à l'intérieur de la gaine de protection.

EE 30 762 *pour plus amples renseignements*

GÉNÉRATEUR DE SIGNAUX À COMMANDE PAR CRISTAL

Solartron Elektronik GmbH, Munich 15, Bayerstrasse 13

(Illustration à la page 118)

Cet instrument, réalisé par la branche allemande de l'organisation Solartron, est basé sur le principe de l'oscillateur à fréquence variable. En pratique, la fréquence de sortie de 50 kHz à 50 MHz est produite sous forme de différence entre une fréquence fixe à pilotage piézo-électrique de 105 MHz et une fréquence variable, mais également pilotée par cristal, de 105,05 à 155 MHz.

L'avantage de ce principe est que n'importe quel genre de modulation peut être appliqué à la fréquence fixe de 105 MHz, cependant que la fréquence de sortie est déterminée par le réglage de l'oscillateur à fréquence variable. La fréquence de cet oscillateur est contrôlée au moyen d'un système de synthèse de fréquence qui permet de régler la fréquence variable en plots de 10 kHz avec toute la précision d'un cristal de contrôle incorporé. Les espaces entre ces points de verrouillage de 10 kHz peuvent être couverts par un oscillateur à fréquence variable de grande précision qui donne un déplacement sur la fréquence des points de verrouillage de −3 kHz à +13 kHz.

Afin de rendre les réglages de fréquence aussi aisés que possible, le système de verrouillage est commandé par deux cadrans. Le premier de ces cadrans, *A*, donne 50 points de verrouillage, soit à chaque mégacycle, de zéro à 50 MHz, le second cadran, *B*, donne 100 points de verrouillage, soit tous les 10 kHz, entre les points de 1 MHz du cadran *A*. Le troisième cadran, *C*, de l'oscillateur à fréquence variable introduit le susdit déplacement sur la fréquence des points de verrouillage.

L'oscillateur à fréquence variable peut être mis hors circuit pour obtenir une fréquence de sortie absolument précise tous les 10 kHz. Pour les applications nécessitant une variation de fréquence continue plus étendue, le verrou électronique de fréquence du cadran *B*, ainsi

que celui du cadran *A*, si nécessaire, peuvent être déclenchés pour assurer une variation continue de 1 MHz des points d'arrêt de 1 MHz du cadran *A* seulement dans son état "libre".

La fréquence de sortie de 50 kHz est produite dans un modulateur annulaire minutieusement étudié. La fréquence fixe de 105 MHz est introduite à une amplitude réduite dans la gamme linéaire de travail du modulateur, de sorte que n'importe quelle modulation sera fidèlement reproduite dans le signal de sortie du modulateur en anneau.

Afin d'utiliser tous les avantages de la souplesse que présente cette méthode d'hétérodynage, la fréquence fixe est injectée à travers des éléments de modulation à fiches facilement interchangeables. Les éléments de modulation à fiches livrables actuellement sont pour modulation d'amplitude, bande latérale unique ou modulation de fréquence.

L'entrée de fréquence variable est à un niveau beaucoup plus élevé, de sorte que les variations d'amplitude de la fréquence variable ne se reflètent pas entièrement dans la sortie de signal du modulateur.

Pour garder le niveau de sortie de signal entièrement constant, indépendamment des variations de fréquence et de charge, la sortie de signal du modulateur en anneau est amplifiée dans un amplificateur à large bande avec commande automatique de niveau de sortie. Grâce à ce moyen, la force électromotrice de sortie est maintenue constante à 1 V de tension efficace avec une précision de ±0,1 dB. Le signal est contrôlé par un appareil de mesure avec une précision absolue de 0.3 dB et il est fourni à travers une résistance de source de précision à la douille de sortie élevée. Un atténuateur à fiches avec neuf plots de 10 dB et neuf plots de 1 dB donne une atténuation précise (précision de ±0,2 dB) du signal de sortie de 1 V qui peut encore être réduit par un complément de 20 dB. La radiation parasite de l'instrument est insignifiante et l'on peut, par conséquent, faire plein usage de la plus faible sortie.

Il existe des éléments à fiches permettant d'étendre la gamme de l'instrument jusqu'à 500 MHz.

EE 30 763 *pour plus amples renseignements*

ENREGISTREUR À BANDE

Distributeurs: Aveley Electric Ltd, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex

(*Illustration à la page 119*)

La société Aveley Electric Limited a récemment présenté un modèle perfectionné de l'Enregistreur à courant continu Enograph de la maison Rohde & Schwarz. Il s'agit d'un instrument potentiométrique à action rapide permettant l'indication linéaire et logarithmique.

L'Enograph comporte de nombreuses caractéristiques intéressantes, dont une impédance d'entrée très élevée allant jusqu'à 10^{11}, une entrée entièrement flottante et dix vitesses de bande différentes, choises par bouton-poussoir. Les vitesses de la bande d'enregistrement sont du rapport de 2 ou 3 à 1, et elles peuvent être choisies d'une gamme de vitesses allant de 10 mm/sec à 20mm/h. On peut aussi actionner la bande à partir d'un organe d'entraînement extérieur ou bien par bouton-poussoir. Le mécanisme extérieur peut être actionné par l'Enograph. La télécommande de la commutation de tension du style et de l'avance du papier est également prévue.

L'Enograph enregistre tous les variables pouvant être représentés par tension directe, tandis que l'impédance d'entrée élevée permet le branchement direct de circuits tels que redresseurs à diodes, discriminateurs, multiplicateurs photoélectriques, circuits de contrôle, circuits de lampes, etc.

Les quatre types d'enregistrement assurés (encre, plume à bille, électrode et style) répondent pratiquement à tous les besoins d'enregistrement.

L'instrument convient tout particulièrement au matériel d'essai exposé aux vibrations, telles que celles se produisant dans les avions ou les véhicules à moteur, car le mécanisme enregistreur est extrêmement solide.

EE 30 764 *pour plus amples renseignements*

TENSION DE RÉFÉRENCE NORMALISÉE

Communications (Air) Ltd, Half Moon Street, Bagshot, Surrey

(*Illustration à la page 119*)

Ce bloc, fonctionnant à partir du courant secteur, remplace efficacement la cellule étalon dans des applications comme l'excitation du potentiomètre dans les enregistreurs à plume, etc. Il fournit une puissance de sortie d'environ 1V avec une stabilité comparable à celle d'une cellule étalon mais avec l'avantage de pouvoir fournir un courant légèrement supérieur (10mA).

La gamme de températures d'utilisation va de −20°C a +55°C et le coefficient de température est de ±0,001%/°. Le changement de sortie pour un changement d'entrée de 10% est de 0.001%.

EE 30 765 *pour plus amples renseignements*

ÉMETTEUR VHF MINIATURE

R.E.E. Telecommunications Ltd, Telecomm Works, Market Square, Crewkerne, Somerset

(*Illustration à la page 119*)

L'émetteur VHF "Telecomm" type TT/3 est un appareil miniature complètement transistorisé, étudié pour l'utilisation sur une fréquence discrète dans la bande de 70 à 100 MHz.

Six transistors sont employés dans un circuit à pilotage piézoélectrique. Une cellule à mercure intérieure permet le fonctionnement continu pendant 70 heures environ. La sortie de puissance de l'émetteur est de 35 mw à peu près, selon la fréquence.

L'émetteur mesure 140 × 76 × 32 mm et son poids est de 284 g. Un microphone à cadre mobile est normalement fourni, ainsi qu'une antenne fouet quart d'onde ou antenne à câble souple.

Un récepteur miniature type TR/3, de grandeur comparable et utilisant un circuit piloté par quartz à double hétérodyne sera bientôt offert à la vente pour l'emploi avec cet émetteur. Quoique ces deux instruments soient prévus pour les communications très rapprochées sur les quais, dans les chantiers de constructions ou de travaux, des essais couronnés de succès ont été effectués sur des distances de près de 8 km.

EE 30 766 *pour plus amples renseignements*

TRANSDUCTEURS

Southern Instruments Ltd, Frimley Road, Camberley, Surrey

(*Illustration à la page 120*)

L'introduction de quatre nouveaux modèles étend encore la gamme déjà fort étendue des transducteurs pouvant être utilisés avec le système SOUTHERN de modulation de fréquence.

Le transducteur Type G304 à pression réduite et à surcharge élevée est du type à inductance prévu également pour le refroidissement par l'eau. Le déplacement du diaphragme est restreint par une butée permettant au transducteur de résister à une pression allant jusqu'a 70 kg/cm². La limite du mouvement du diaphragme et, par conséquent, la sortie maxima, est atteinte à une pression bien inférieure. Le transducteur a été étudié pour n'importe quelle gamme de 0 à 0,7 et de 0 à 7 kg/cm² et il convient aux applications exigeant la mesure de faibles pressions dans un système soumis à des pressions de grand choc. Ces dernières sont sans effet sur la gamme ou le réglage zéro.

Le transducteur G302 est du type à inductance avec diaphragme affleurant. Cela élimine le volume sans emploi et le problème de la fréquence de traversée qui vont de pair avec un transducteur ayant un diaphragme rentré, et permet le montage sans modification du volume de l'objet soumis à l'essai. Il peut être fourni avec n'importe quelle gamme de 0 à 0,7 et de 0 à 703 kg/cm². La linéarité et l'hystérésis sont supérieurs à ±1% de la gamme totale. Une surcharge de 100% n'affecte pas le transducteur qui fonctionne jusqu'à 150°C sans refroidissement. Il a une réponse à haute fréquence et il peut être étalonné statiquement.

Le capteur de vibrations de torsion type G218 a été perfectionné et il est maintenant désigné par le type G318. Ce transducteur du type à inductance n'a ni collecteurs ni contacts mobiles. La nouvelle version est donc plus appropriée pour les grandes vitesses et elle est d'un fonctionnement plus sûr dans les conditions "d'expiration" et de non-axialité. La sortie est directement proportionnelle au mouvement angulaire dans la gamme de ±4°. Il peut être

étalonné, dans les conditions statiques, dans la position d'essai à l'aide du calibre de montage prévu à cet effet.

Le transducteur de pression type G319 complète le groupe. C'est un transducteur du type capacité pouvant fonctionner jusqu'à 500°C sans refroidissement.

EE 30 767 *pour plus amples renseignements*

FRÉQUENCEMÈTRE

Telemechanics Ltd, Brockenford Lane, Totton, Southampton, Hampshire

(Illustration à la page 120)

Ce fréquencemètre à lecture directe peut produire et mesurer n'importe quelle fréquence discrète de 1 kHz à 3000 MHz et ses proportions de stabilité sont de 2 parties dans 10^{-8} à 4 parties dans 10^{-10}. Se prêtant à l'entraînement et au contrôle de systèmes à bande latérale unique, à l'excitation de résonances magnétiques nucléaires, il convient également à l'utilisation en liaison avec les aides à la navigation à transmission unique, les appareils de référence pour laboratoires scientifiques industriels et d'enseignement. Il est doté d'une sortie d'attaque et on peut, en outre, enficher un compteur extérieur.

Le fréquencemètre T.D.I. est portatif et c'est le premier modèle incorporant un cristal qui donne une précision de 2 parties dans 10^8 après une heure. L'impédance intérieure est de 75 ohms, la tension de sortie sur les fréquences fondamentales est de 100 mW, la tension d'entrée sur les fréquences fondamentales et harmoniques est de 1 mV et le niveau de fréquence parasite est de −80 dB. Les changements de tension, la détérioration des lampes et les chocs physiques ne provoquent aucun changement sensible de fréquence ou de phase.

EE 30 768 *pour plus amples renseignements*

PRODUCTION DE SIGNAUX SUR MICROONDES

Schomandl K.G., Munich 8, Belforstrasse, 6-8 Allemagne

(Illustration à la page 120)

Le fréquencemètre à décades pour microondes type FD3 fait partie d'une gamme étendue d'instruments de mesure de fréquences fabriqués par la susdite société.

L'étalon de fréquence de base utilisé est un cristal de 100 kHz et la sortie peut être bloquée sur cet étalon à intervalles de 100 kHz. L'accord continu est également prévu, la gamme fondamentale étant de 300 MHz à 1000 MHz avec une précision de ±300 Hz. Des harmoniques sont produits qui étendent la gamme à 12,6 kMHz.

Une combinaison du FD3, d'un fréquencemètre à décades type ND5 et d'un appareil à décades de précision type NDF1 assure une précision portée à ±1 Hz pour n'importe quelle fréquence dans la gamme de 300 à 1000 MHz.

La puissance de sortie dans la gamme fondamentale est de 1 mW tandis que la sensibilité, lorsque l'instrument est employé comme fréquencemètre, est de 100 μW. L'indication des battements est fournie par écouteurs ainsi que par un indicateur d'accord à "oeil magique".

EE 30 769 *pour plus amples renseignements*

INSTRUMENTS DE MESURE ÉLECTROSTATIQUES DE CONTACT

Nalder Bros. & Thompson Ltd, 97 Dalston Lane, London E.8

(Illustration à la page 120)

Cette nouvelle gamme d'instruments a été conçue de manière à approcher davantage le fonctionnement théorique possible avec ce type de voltmètre. Grâce au couple accru réalisé, il a été possible de produire une série de voltmètres de contact électrostatiques.

Les contacts de l'appareil, qui peuvent être réglés extérieurement en cas de commande de surtension ou de sous-tension, ne sont pas chargés de porter le courant par suite du fait qu'ils sont incorporés dans le circuit de grille d'un amplificateur à tubes connexe, le courant principal d'alarme ou de disjonction étant porté par relais solenoïdaux interchangeables.

Les limites de fonctionnement de ces instruments sont de 100 V à 75 kV.

Notre gravure montre un instrument à 10 kV avec amplificateurs de contact.

EE 30 770 *pour plus amples renseignements*

CONDENSATEURS AU TANTALE SOLIDE

Texas Instruments Ltd, Dallas Road, Bedford

Les condensateurs type SCM "tan-TI-cap" sont livrables en 203 combinaisons courantes de capacité-tension et dans les catégories de tension courantes de 6, 10, 15, 20, 25 et 35 V c.c. Ils sont fabriqués en quatre formats de boîtier.

Les spécifications de rendement indiquent le fonctionnement sur tension nominale, de −55°C à +85°C et à 135°C aux deux tiers de la tension nominale; enfin, un fonctionnement stable de −80°C à +125°C. Ces condensateurs à grand rendement sont 100% à l'épreuve des courants de fuite (bruits) et leur taux de panne est garanti supérieur à 2×10^{-8} lorsqu'ils sont utilisés à leur valeur nominale maxima.

Parmi les autres caractéristiques, signalons les boîtiers de formats industriels courants sous-miniature, une capacité de tension inverse continue, une grande résistance aux chocs et aux vibrations et un fini d'une grande résistance à la corrosion. Des connexions axiales sur supports et sans scellements extérieurs facilitent le montage et peuvent être fortement pliés sans se rompre.

Ces condensateurs sont à électrolyte plein et à anode au tantale fritté et ils utilisent un film diélectrique à l'anhydride de tantale d'une haute intégrité et d'une épaisseur maximum pour chacune des catégories de tension. Cette construction assure le maintien de leurs caractéristiques pendant des périodes de magasinage de longueur indéfinie car ils ne peuvent ni avoir de fruites, ni se déshydrater ni être affectés par la température.

EE 30 771 *pour plus amples renseignements*

GÉNÉRATEUR D'IMPULSIONS

Solartron Laboratory Instruments Ltd., Cox Lane, Chessington, Surrey

(Illustration à la page 121)

Le Générateur d'impulsions décadaires Solartron GO1005 permet de déterminer avec précision les caractéristiques de transmission et la réponse transitoire d'amplificateurs et de circuits, ou de vérifier les limites de fréquence et d'amplitude de compteurs électroniques. Cet instrument fournit des impulsions rectangulaires simples ou doubles, à direction positive ou négative, d'une amplitude allant jusqu'à 100V et à des taux de répétition de 10 Hz à 1 MHz.

Trois séries de commandes de décades concentriques, avec cadrans éclairés, assurent le réglage précis ou approximatif de la durée des impulsions, du taux de répétition et du délai du signal. A l'aide de l'appareil incorporé de contrôle de l'amplitude, le débit voulu peut être réglé sans difficulté et avec précision.

Le délai du signal relatif à un débit de 10V de préimpulsion est variable dans la même gamme que la durée d'impulsion rectangulaire, soit de 250 μsec à 100msec.

Pour le mode de fonctionnement à double impulsion, le flanc avant de la première impulsion rectangulaire coïncide avec la préimpulsion, et le flanc avant de la seconde impulsion rectangulaire identique apparaît après délai du signal fixé.

Une préimpulsion retardée est également produite environ 250 μsec après la préimpulsion, fournissant ainsi un débit de déclenchement de l'impulsion rectangulaire principale.

EE 30 772 *pour plus amples renseignements*

BLOC DE MINUTAGE

Dynatron Radio Ltd, Maidenhead, Berkshire

(Illustration à la page 121)

Cet élément de minutage a été principalement conçu pour travailler avec les dispositifs de comptage de la série 1009 dont il obtient son alimentation. La fonction essentielle de l'élément de minutage est de débrancher le dispositif de comptage, soit à un moment préréglé soit après un nombre de coups de comptage préréglés et de permettre la lecture des totaux de temps et de comptage à partir de tubes de comptage à décades étalonnés.

Le N108 a un registre de temps maximum de 100 000 sec et lorsqu'il est utilisé en liaison avec le dispositif de comptage, il a un registre de comptage maximum de 1 000 000 coups. Un avan-

tage supplémentaire du N108 est qu'il autorise le fonctionnement du dispositif de comptage à sa durée de résolution maximum de 1μsec, permettant ainsi d'utiliser le taux de comptage maximum du dispositif de comptage.

Notre gravure montre le bloc de minutage fixé au dispositif de comptage type 1009E.

EE 30 773 *pour plus amples renseignements*

POTENTIOMÈTRE MINIATURE

Miniature Electronic Components Ltd, The Lye, St. Johns, Woking, Surrey

(Illustration à la page 121)

Ce potentiomètre miniature bobiné de précision et à spire unique est fabriqué sous licence de la Technology Instrument Corporation of America et il a été spécialment conçu pour les avions et engins téléguidés. Son diamètre maximum est de 1,27 cm et sa grandeur totale est de 2,61 cm.

Il est capable d'évacuer 1,5 W à 80°C, sa gamme de températures va de −55 à +180°C et il est livrable en dix valeurs normales de 50 ohms à 50 kiloohms.

EE 30 774 *pour plus amples renseignements*

ENREGISTREUR DE pH (INDICE DE SÖRENSON)

Analytical Measurements Ltd, Dome Buildings, The Quadrant, Richmond, Surrey

(Illustration à la page 121)

Cet instrument à lampes normales utilise un amplificateur à modulation électronique qui compense les fluctuations de tension de secteur. Un dispositif etnregistreur à bande constitue le panneau frontal de l'instrument et contient un rouleau de papier d'enregistrement de 19,2 m se déroulant à la vitesse 2,5 cm/heure et pouvant durer 31 jours. Des vitesses supérieures, allant jusqu'à 40,6 cm/heure, peuvent être atteintes sur simple changement de vitesse. Le papier d'enregistrement est revêtu d'un enduit sensible à la pression. Des connexions pour l'insertion d'un thermomètre à résistance platinée assurent la compensation automatique de température. Un commutateur sur le panneau frontal permet de déconnecter l'entraînement du papier de façon à ce que l'instrument devienne un appareil indicateur de pH. Le dispositif à sonde de pH analytique fournit un système unitaire à électrode de verre complètement protégé par du polyéthylène.

EE 30 775 *pour plus amples renseignements*

TUBES HYPERFRÉQUENCES

Standard Telephones & Cables Ltd, Connaught House, Aldwych, London W.C. 2

(Illustration à la page 121)

L'adjonction à la gamme existante de deux nouveaux tubes oscillateurs à ondes TE permet maintenant de couvrir avec quatre tubes la bande de fréquences de 5850 à 7770 MHz. Ces tubes ont chacun une gamme d'accord électronique de ±8.5 MHz et une sortie de puissance minimum de 800 mW. Ils ont une excellente stabilité de fréquence, une tension réduite de fonctionnement et leur refroidissement par radiation seulement est adéquat.

Ces tubes sont du type V261C/M (5850 à 6350 MHz) et V266C/IM (6350 à 6850 MHz).

Un cinquième tube du type à onde TE, le V265A/IM, n'est accordable que mécaniquement et il a une sortie de puissance minimum de 200 mW dans la gamme de fréquences de 5850 à 7100 MHz.

Un nouveau tube oscillateur modulé en vitesse, du type à ligne coaxiale, désigné par la référence V231C/IK, est principalement prévu pour l'utilisation avec le radar à bande S. Ce tube couvre la bande de fréquences de 3050 à 3180 MHz, avec une sortie de puissance minimum de 40 mW. It est étudié pour l'emploi dans une cavité du type 495-LVA-252 qui est un élément compact avec une sortie de guide d'ondes type WG10. Le cas échéant, ce tube peut être accordé électroniquement dans une gamme de ±8 MHz au minimum.

Le tube limiteur à ondes progressives, type W9/BE, que l'on voit dans la gravure, couvre la bande de fréquences de 2500 à 4100 MHz. Il a un gain à faible puissance de 15 ±3 dB et une sortie de puissance saturée de −7 à −13 dBm. Ce tube est destiné à la protection contre les surintensités dans tout matériel où une gamme très étendue de puissance d'entrée est prévue et il assure également un gain utile à de faibles niveaux d'entrée.

Une solenoïde de focalisation en feuille d'aluminium est fournie (type 459-LVA-007). Elle comporte des connexions coaxiales haute-fréquence d'entrée et de sortie.

EE 30 776 *pour plus amples renseignements*

Résumés des Principaux Articles

L'électroluminescence; ses caractéristiques et ses applications par D. H. Smith

Résumé de l'article aux pages 68 à 72

La première partie de cet exposé décrit les caractéristiques de la lumière émise par des cellules électroluminescentes excitées par ondes sinusoïdales ainsi que les impulsions de tension. Le mécanisme de l'électroluminescence est brièvement discuté.

La deuxième partie examine certaines des nombreuses applications. On peut employer, par exemple, les cellules électroluminescentes comme sources de lumière de même que pour la présentation visuelle d'informations. Des amplifications de lumière peuvent être réalisées à partir d'une combinaison d'éléments électroluminescents et photoconducteurs. Il serait en outre, possible d'employer un réseau de cellules électroluminescentes minuscules, sous forme d'indicateur de télévision à écran mince.

Générateurs d'impulsions de condensateurs par E. R. Wooding

Résumé de l'article aux pages 73 à 76

La série de courbes universelles figurant dans cet article facilite le calcul de la forme, du courant, de la puissance et de la durée de l'impulsion obtenue en déchargeant un condensateur au moyen d'une charge inductive comme, par exemple, un tube à décharge utilisé comme source de lumière à action rapide.

Un amplificateur sélectif résistance-capacité à transistors par R. Hutchins

Résumé de l'article aux pages 84 à 87

Cet article étudie l'emploi de réseaux déphaseurs dans les circuits à transistors. La dualité du bras du pont de Wien est utilisée pour former un oscillateur et un amplificateur sélectif. L'amplificateur sélectif que décrit l'article est à sélectivité et accord à variation continue cependant que le gain demeure constant.

Le Transistor par diffusion et alliage par E. Wolfendale

Résumé de l'article aux pages 88 à 93

L'auteur démontre que la méthode ordinaire de fabrication des transistors à jonction par alliage n'autorise aucune nouvelle exploitation aux hyperfréquences, et il indique le mode de fabrication du transistor à jonction par diffusion et alliage ainsi que les raisons de ses avantages.

Il décrit ensuite le comportement des transistors par diffusion et alliage dans un nombre de circuits caractéristiques.

Après avoir examiné ce que sera vraisemblablement la gamme future de transistors à jonction par alliage et diffusion, il en conclut que lorsque cette gamme sera pleinement établie, il sera possible de remplacer les lampes thermoélectroniques pour la plupart des usages, à l'exception du travail à hyperfréquences et de la transmission de puissance.

Lits fluidisés constituant des enceintes de température constante pour l'essai des composants électroniques par H. Sutcliffe

Résumé de l'article aux pages 94 à 95

Le problème du maintien des composants électroniques à une température connue et constante afin de mesurer leurs caractéristiques est traité dans cet article. La technique dite du "lit fluidisé", ou l'enceinte de température constante est formée par un lit de particules solides flottant sur un courant montant d'air est une variante des méthodes existantes. L'article décrit la construction et le comportement d'un petit lit fluidisé et en arrive à la conclusion que la méthode du lit fluidisé comporte de nombreux avantages.

Un élément de calcul universel par C. B. Taylor

Résumé de l'article aux pages 96 à 99

L'élément décrit est essentiellement un "refaçonneur" de formes d'ondes jumelées à longue persistance qui, de même qu'un certain nombre de déclencheurs d'entrée logiques, peut avoir de nombreux usages en tant qu'élément de base pour un système de calcul. Le but principal de sa conception était de produire un calculateur binaire économique à circuits logiques à transistors diodes, mais parmi les multiples autres usages de l'élément il y a ceux de générateur d'impulsions, de simple "refaçonneur", de dispositif de temporisation à sorties biphasées corrigées, d'élément bistable, et de générateur d'ondes carrées non-asservi.

Un filtre passe-bande à largeur de bande variable par J. Holland

Résumé de l'article aux pages 100 à 105

L'auteur décrit une méthode par laquelle plusieurs largeurs de bande peuvent être obtenues dans un filtre capacitif inductif n'utilisant qu'un seul jeu d'inducteurs. La description inclut la réalisation d'un filtre type avec un tracé effectif de ses caractéristiques d'atténuation.

Une méthode rapide pour l'étude de filtres Butterworth par J. S. Bell et P. G. Wright

Résumé de l'article aux pages 106 à 108

Le filtre du type Butterworth comporte de multiples avantages par rapport aux filtres de conception classique, pour de nombreuses applications. Un aperçu de ces avantages est donné par l'auteur qui indique un procédé d'étude et examine une réalisation selon cette méthode.

ELEKTRONISCHE GERÄTE

Beschreibung neuer Bauelemente, Zubehörteile und Prüfgeräte auf Grund der von Herstellern gemachten Angaben.

Übersetzung der Seiten 116 bis 121

SELEKTIV-MIKROVOLTMETER

Vertrieb: Aveley Electric Ltd, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex

(Abbildung Seite 116)

Der von Rohde und Schwarz hergestellte "Selektomat" Typ USWV ist ein Messüberlagerungsempfänger mit einem elektrisch abgestimmten örtlichen Oszillator. Obwohl er hauptsächlich als Zusatzgerät zum "Polyskop" entwickelt wurde, kann er mit jedem Wobbel- oder Standardmessender benutzt werden, der innerhalb des Frequenzbereiches arbeitet.

Der Frequenzbereich von 30...400 MHz ist in sieben Bänder unterteilt; die Abstimmung kann entweder von Hand oder automatisch erfolgen; die automatische Nachlaufschaltung folgt zwangsläufig der gewählten, in den Eingang gespeisten Frequenz.

Die Mindesteingangsspannung ist 10 μV_{eff}, der Frequenzgang 0,2%/MHz±dB und die Eingangsdämpfung 0...60 dB. Die Bandbreite ist 125 kHz (−3 dB) und 1 MHz (−80 dB). Die logarithmische Anzeige ist 0...80 dB und die lineare Anzeige mit dem zusätzlichen 60 dB Abschwächer 0...20 dB.

Der Selektomat ist ideal für Frequenzgangmessungen 2- oder 4-poliger Netzwerke, z.B. von Filtern, Verstärkern und Dämpfungsgliedern sowie für Messung der Eingangsreflexion 4-poliger Netzwerke, des Reflexionsfaktors von Antennen unter Benutzung von Reflexionsmessern usw.

EE 30 751 *für weitere Einzelheiten*

ZENTIMETERWELLEN-SIGNALQUELLE

Vertrieb durch: Livingston Laboratories Ltd, Retcar Street, London N.19

(Abbildung Seite 116)

Die Hewlett-Packard Company hat ein System zur Breitband-Leistungserzeugung von Mikrowellenfrequenzen herausgebracht. Der Bereich von 18 bis 40 GHz wird mit zwei Frequenzverdopplern Typ 938A und Typ 940A überstrichen. Modell 938A liefert Leistung von 18...26,5 GHz, wenn es von einer Quelle mit 9...13,25 GHz getrieben wird; Modell 940A von 26,5...40 GHz von einer Treiberquelle mit 13,25...20 GHz.

Der Frequenzverdoppler besteht im wesentlichen aus einem in Hohlleiter eingebauten quarzgesteuerten Breitband-Oberwellengenerator; ein Leistungsmonitor und ein Präzisionsdämpfungsregler sind auch eingebaut. Beide Modelle können von Klystrons, Messendern oder Ablenkoszillatoren getrieben werden. Da Modelle 938A und 940A Breitbandgeräte sind, kann das Eingangssignal aus CW, Impulsen oder Überstreichungen bestehen. Das Ausgangssignal wird daher die Kennzeichen der Treiberquelle beibehalten.

Beide Frequenzverdoppler haben eingebaute Leistungsmonitors und Präzisions-Drehflügeldämpfungsregler, die genaue Einstellung des Leistungspegels von 0...100 dB mit absoluter Pegelgenauigkeit von ±1 dB für die meisten Frequenzen ermöglichen. Die zusätzliche Dämpfungsreglergenauigkeit ist 2% der Ablesung oder ±0,2 dB, wobei immer der grössere Wert gültig ist. Das Stehwellenverhältnis für max. Ausgangsleistung ist in der Grössenordnung von 2:1 und unter 1,2:1, wenn der Dämpfungsregler auf −10 dB oder mehr eingestellt ist.

EE 30 752 *für weitere Einzelheiten*

Paris · 17.-21. Februar 1961
Besucher der Ausstellung
SALON INTERNATIONAL DES COMPOSANTS ÉLECTRONIQUES
sind auf dem Stand von
ELECTRONIC ENGINEERING
herzlich willkommen.

STABILISIERTE GLEICHSTROM-VERSORGUNGSGERÄTE

Claude Lyons Ltd, Valley Works, Hoddesdon, Hertfordshire

(Abbildung Seite 116)

Die neue Serie stabilisierter Gleichstromversorgungsgeräte ist zum Einbau in eigene Geräte von Herstellern bestimmt.

Der Baustein besteht aus einer herkömmlichen Gleichstromversorgung (Abwärtsumspanner, Brückengleichrichter und Glättungskondensator), deren Eingang durch einen Transduktor gespeist wird. Ein transistorisierter, gegengekoppelter Verstärker misst die Ausgangsspannung der Stromversorgung und reguliert laufend die an der Reglerwicklung des Transduktors liegende Gleichspannung, so dass die Ausgangsspannung über einen grossen Schwankungsbereich der (Netz-) Eingangsspannung und -frequenz und der Ausgangsstrombelastung konstant gehalten wird.

Die Stromversorgung enthält keine Röhren und ist äusserst betriebssicher. Die Restwelligkeit ist sehr niedrig: in der Grösenordnung von 1%. Die Ausgangsspannung kann innerhalb eines Bereiches von ±15% des Nennwertes geregelt werden. Besonders zu erwähnen ist der dem Gerät eigene hochgradige Kurzschlussschutz.

Bisher sind Modelle für folgende Leistungen lieferbar: 12 V 8 A; 20 V 5 A; 24 V 4 A; 32 V 3 A und 48 V 2 A.

EE 30 753 *für weitere Einzelheiten*

VERÄNDERLICHE MAGNETOSTRIKTIONS-VERZÖGERUNGSLEITUNG

Ferranti Ltd, Holliwood, Lancashire

(Abbildung Seite 116)

Magnetostriktions - Verzögerungsleitungen, in denen mechanische Impulse entlang Drähten übertragen werden, fin-

den seit einigen Jahren für Speicherung und Zeitverzögerungszwecke in Rechnern, Simulatoren und anderen elektronischen Systemen Verwendung. Die Technik, die stufenlose Regelung der Zeitverzögerung ermöglicht, ist erst neuerdings genügend weiterentwickelt worden, um Herstellung eines zuverlässigen Fabrikates zu gewährleisten.

Ferranti Electric Inc. in New York haben vor kurzem veränderliche Magnetostriktionsleitungen eingeführt, deren Verzögerung über den ganzen Bereich von 2μs...10 ms regelbar ist. Die Ziffernfrequenz geht bis zu 500 kHz, und die Schwankungen in der Verzögerungszeit sind geringer als 1 ns. Die Einstellung der Verzögerungszeit ist linear und die Wiederholungsgenauigkeit 0,1%.

Die stufenweise Änderung der Verzögerungszeit erfolgt durch mechanische Regelung mittels eines umlaufenden Kugelkäfigantriebs für niedrige Drehmomente und ist für manuellen oder Servobetrieb geeignet. Mikroschalter geben eine elektrische Anzeige der Änderungsgrenzen und mechanische Anschläge verhindern Überlastung.

EE 30 754 *für weitere Einzelheiten*

STECKVERBINDUNG FÜR THERMOELEMENTE

West Instrument Ltd, Regent Street, Brighton, Sussex

(Abbildung Seite 117)

Es wird beansprucht, dass bei diesem öl- und wasserdichten Thermoelementstecker die in der Verbindung zur Verlängerungsleitung oft auftretenden Fehler vermieden werden.

Er ist als Abschluss für Thermoelemente geeignet, mit dessen Hilfe schnelle und leichte Verbindungen zu Verlängerungsleitungen hergestellt werden können. Thermoelemente können ausgewechselt werden, ohne dass die oft komplizierte und teure Verdrahtung gestört wird. Anschlussleisten und andere Verbindungen, die bei Vibration und durch Verschmutzung und andere Faktoren Fehler hervorrufen können, werden vermieden.

Pole und Buchsen der Steckvorrichtung werden aus ausgewählten Materialien hergestellt, um Streu-EMKs zu vermeiden, die durch das Temperaturgefälle über Stecker und Kupplung hervorgerufen werden können. Die Vorrichtung ist polunverwechselbar, um fehlerhafte Verbindungen auszuschliessen.

EE 30 755 *für weitere Einzelheiten*

TISCH-ANALOGRECHNER

Telefunken GmbH, Berlin-Charlottenburg, 1

(Abbildung Seite 117)

Der Tisch-Analogrechner RAT 700 ist ein volltransistorisierter Gleichspannungsrechner. Er ist aus Bausteinen aufgebaut, die die Zusammenstellung von Analogrechenmaschinen jeder beliebigen Grösse und Kapazität von einzelnen Rechenelementen bis zur Grossanlage gestatten.

Mehrere Rechner können parallelgeschaltet werden und Fernsteuerung ist vorgesehen. Der Ausgangsoszillograph OMS 700 wurde besonders für den Tischrechner entwickelt.

Ein Rechner RAT 700 besteht nach Wahl aus:

10 bis 15	Operationsverstärkern, von denen
6 bis 8	auf Integration/Summation und
4 bis 7	auf Summation umgeschaltet werden können;
0 bis 4	Multiplikatoren,
20	Koeffizientenpotentiometern,
0 bis 2	Funktionsgebern,
8	Dioden,
0 bis 2	Relais.

Rechenwiderstände und zwei Kondensatoren für jeden Integrator sind eingebaut. Die Operationsverstärker sind chopperstabilisiert, so dass ausser repetierendem und Einmal-Rechnen auch Dauer-Rechnen möglich ist.

Die ausschliessliche Verwendung von Halbleitern gewährleistet hohe Betriebssicherheit. Der Rechner ist verhältnismässig leicht (80 kg), und der geringe Leistungsbedarf (90 VA) erfordert weder Belüftung noch Klimaanlagen.

EE 30 756 *für weitere Einzelheiten*

BORDMAGNETBANDGERÄT

Sir W. G. Armstrong Whitworth Aircraft Ltd, Baginton, Nr. Coventry, Warwickshire

(Abbildung Seite 117)

Dieses Bordmagnetbandgerät wurde ursprünglich für Flugkörper entwickelt, die über dem Erprobungsgelände Woomera abgeschossen wurden.

Auf 3 oder 7 Spuren eines mit 190,5 cm/s an den Magnetköpfen vorbeilaufenden 6,35 oder 12,7 mm breiten Bandes wird eine Trägerfrequenz von 50 kHz bis zur Sättigungsgrenze sowohl in positiver als auch negativer Richtung aufgenommen. Die zu erfassenden Messwerte werden zur Frequenzmodulation des Trägers innerhalb der Grenzen von 35 und 65 kHz benutzt, d.i. mit einem Frequenzhub von ±15 kHz. Auf der vierten und achten Spur wird ein quarzgesteuertes 100 kHz Bezugssignal aufgenommen, das während der Wiedergabe dazu benutzt wird, die Frequenz der Datenkanäle als ganzzahligen Teiler seiner eigenen Frequenz zu messen und die Zeitfolge zu markieren. Daraus ist ersichtlich, dass die Genauigkeit der Frequenzmessung vom Bezugssignal und nicht von der Bandgeschwindigkeit abhängt, die aber trotzdem innerhalb enger Toleranzen gehalten werden muss. Auf dem 6,35 mm Band sind drei und auf dem 12,7 mm Band 7 frequenzmodulierte Spuren, die als "Messwertspuren" bezeichnet werden; die vierte bezw. achte Spur wird als "Bezugsspur" bezeichnet und auch zur Aufzeichnung einer Nullzeitmark benutzt, die den Start der Datenerfassung und der Zeitfolgezählung kennzeichnet.

Das Laufwerk sieht ziemlich herkömmlich aus und besteht aus einer durch Reibung leicht gebremsten Ablaufspule, einer motorgetriebenen Achse, die das Band mittels Gummiandruck- und Stahlrollen am Kopf vorbeiführt. Die Andruckrollen werden durch einen exzentrischen Nocken betätigt und die Aufnahmespule durch einen getrennten Gleichstrommotor getrieben. Die Geschwindigkeit des Hauptantriebmotors erfolgt durch elektronische Regelung der Feldspannung, deren Eingangsdaten von einem Impulsschalter an der Motorachse geliefert werden. Die Geschwindigkeit des Aufnahmespulenmotors wird nur durch den Bandzug geregelt.

Die Bandspulen sind besonders konstruiert, um Flugbeschleunigung und Schwingungskräften zu widerstehen sowie das Band gegen Aufschlagkräfte zu schützen. Letztere werden hauptsächlich vom Laufwerk und Deckel aus hochfestem Stahl aufgefangen.

Die aus dem Laufwerk hervorragenden Motoren und die volltransistorisierten elektronischen Schaltungen sind in einem leichten, am Laufwerkchassis befestigten Stahlgehäuse untergebracht. Alle diese Teile können beim Aufschlag abscheren und werden als nicht bergbar betrachtet. Die Aufschlaggeschwindigkeit auf harte Erde und Ausrüstung ist 120 m/s, und die Magnetbänder wurden in fehlerfreiem Zustand aus Geräten geborgen, die negativen Beschleunigungen zwischen 2500 und 3500 *g* ausgesetzt waren.

EE 30 757 *für weitere Einzelheiten*

OFEN FÜR THERMOELEMENTE

George Kelk Ltd, 5 Lesmill Road, Don Mills, Ontario, Canada

(Abbildung Seite 117)

Ein Ofen für Vergleichsthermoelemente, der Vergleichsstellen für bis zu 48 Messthermoelemente aufnehmen kann und nur 3,6 kg wiegt, wird von George Kelk Ltd hergestellt. Benutzung einer getrennten Vergleichsstelle vermeidet die in an Masse liegenden Thermoelementen auftretenden Fehler.

Die Temperatur der Vergleichsstellen wird über einen grossen Umgebungstemperaturbereich innerhalb 0,5% konstant gehalten.

Geeignete getrennte Legierungsanschlussteile für die externen Thermoelemente, sowie Mehrfachanschlussbuchsen für Ausgangsschaltungen sind vorgesehen. Das Gerät kann für Gleich- oder Wechselstrombetrieb geliefert werden.

EE 30 758 *für weitere Einzelheiten*

MESSBRÜCKEN FÜR KLEINE WIDERSTÄNDE

Startronic Ltd, 117a Malden Road, New Malden, Surrey

(Abbildung Seite 118)

Modell 100 ist eine Messbrücke für den Bereich 0,05Ω...50kΩ in fünf Doppeldekadenstufen mit einer Genauigkeit von 0,5%. Das Instrument hat eine Grundfläche von 127 × 190,5 mm mit einer Instrumentplatte, die zwecks leichter Bedienung von 101 mm auf 50 mm nach vorn abfällt. Eine interne 4,5 V Hochleistungsbatterie dient als Stromquelle.

Die geeichte Skala hat 100 mm Durchmesser, und als Nullanzeiger dient ein Präzisions—Drehspulinstrument mit Spiegelskala. Die Genauigkeit der Normalwiderstände ist besser als 0,1%.

Das Instrument kann auch mit Einzeldekadenstufen für einen Gesamtbereich von 0.05Ω...5 kΩ geliefert werden. Beide Ausführungen sind zur Abnahmeprüfung von Zulieferungen, Fertigungskontrolle und im Labor ideal.

Zwei Abwandlungen des Instrumentes, Modelle 108 und 110. sind in derselben Gehäuseausführung lieferbar.

Modell 108 hat einen Einzelbereich von 0...160 mΩ mit einer vom Skalenteil abhängigen Genauigkeit von ±1 mΩ oder ±2%. Messungen können mit im zu messenden Widerstand fliessenden Strom von 0,1 A, 0,2 A, 0,3 A oder 0.6 A vorgenommen werden. Direktmessungen können am Ende von Prüfleitungen mit 10 mΩ Gesamtwiderstand erfolgen. Das Instrument kann zur Messung von Übergangs- und Verbundwiderständen eingesetzt werden.

Modell 110 ist eine Brückenwaage für direkt geeichte Anzeige von ±10% mit Klemmen für externe Normale, in der je nach Kundenwunsch bis zu vier umschaltbare interne Normale vorgesehen werden können. Die Skaleneichung ist bis zu 1% in 0,1% Intervallen und zwischen 1% und 10% in 0,5% Intervallen. Die Eichgenauigkeit bis zu 5% ist 0.1% und von 5% bis 10% 0,2%. Der Widerstandsbereich ist 5Ω...10 kΩ.

EE 30 759 *für weitere Einzelheiten*

"SERVO-POT"-FOTOTRANSISTOR

Sangamo Weston Ltd, St. George Court, 22-26 New Oxford Street, London W.C.1

(Abbildung Seite 118)

Dieses Modell ist im Grunde genommen ein Gleichstromverstärker, der unter Verwendung eines Fototransistors und Galvanometers in Brückenschaltung einen Ausgangsstrom abgibt, der dem Millivolteingang direkt proportional ist. Ein Vorteil dieser Schaltung ist, dass der Eingangsquelle kein nennenswerter Strom entnommen wird.

Der Servo-Pot ist für eine 24 V—Gleichstromversorgung ausgelegt und gibt für 10 mV einen Standardausgang von 1 mA. Ein Stecker bildet die Basis, und das Gerät ist ungefähr 76 mm lang bei einem Durchmesser von 30 mm.

EE 30 760 *für weitere Einzelheiten*

DIGITAL-UHR

Microcell Electronics Ltd, Blackwater, Camberley, Surrey

(Abbildung Seite 118)

Dieses Gerät wurde als Baustein für das Microcell Messwerterfassungssystem mit Abtastung und Warnung Typ 300 für 19"-Gestelle entwickelt, ist aber auch als abgeschlossenes Gerät lieferbar.

Die treibende Grundfrequenz von 50 Hz wird dem Netz entnommen und in Transistor-Stufen durch Teilung auf 1 Hz gebracht. Die weitere Frequenzteilung durch Einsteck-Kleindrehwähler ergibt Stunden, Minuten und Sekunden.

Eine Sechs-Dekaden-Digitalanzeige gibt die Zeit in Stunden, Minuten und Sekunden. An 6 der 45 Leitungen steht Leistung zum Betrieb eines Druckers zur Verfügung.

Programmierte Zeitintervalle, die einen Kontakt herstellen oder einen Spannungsimpuls hervorrufen, können durch Wahl von Schalterpositionen für 1, 2, 5, 10, 20, 30 oder 60 min eingestellt werden. Ausserdem kann dieselbe Schliessung der Kontakte oder Hervorrufung des Spannungsimpulses für präzise Stunden durch Einführung eines Stiftes in ein 24-Positionen-Lochfeld eingestellt werden, so dass typische programmierte Zeiten wie 0000, 0600, 0800, 1100, 1500, 1800 vorgewählt werden können.

EE 30 761 *für weitere Einzelheiten*

ZF-MINIATUR-ÜBERTRAGER

The Wireless Telephone Co. Ltd, Vicarage Lane, Ilford, Essex

(Abbildung Seite 118)

Die Wireless Telephone Company Ltd, eine Firma der Plessey Gruppe, hat eine neue Serie von ZF-Bandpass-Miniatur-Übertragern angekündigt, die für tragbare transistorisierte Empfänger mit Zwischenfrequenzen im Bereich 450... 480 kHz entwickelt wurden. Das Hauptkennzeichen dieser neuen Übertrager ist die Parallelmontage der Spulen, die stabile Kopplung und kompakten Zusammenbau ermöglicht. Die Ferrit-Topfkerne sind zur Erzielung guter mechanischer Stabilität und Schwingungsfestigkeit mit Epoxyharz vergossen. Die Becherabmessungen wurden auf 27 × 16 mm bei 17,5 mm Höhe reduziert.

Für die ersten beiden Stufen werden Übertrager mit Doppelabstimmung und für die dritte Stufe einer mit Einzelabstimmung benutzt. Der ZF-Abgleich erfolgt mittels Abgleich-Massekernen, die eine neuartige Konstruktion aufweisen; an Stelle des Schraubkernes wird ein glatter Kern an eine Polystyrolschraube gekittet, die in einem Gewindeloch des Spulenkörpers läuft. Diese robuste Abgleichschraube kann mit dem üblichen Schraubenzieher mit Metallblatt verstellt und nach endgültigem Abgleich mit Wachs versiegelt werden.

Der Abschirmbecher des Übertragers für die dritte Stufe enthält auch die eingebaute Diode und den HF-Ableitkondensator.

EE 30 762 *für weitere Einzelheiten*

QUARZGESTEUERTER MESSENDER

Solartron Elektronik GmbH, München 15, Bayerstrasse 13

(Abbildung Seite 118)

Das von der deutschen Tochtergesellschaft der Solartron-Gruppe entwickelte Gerät beruht auf dem Überlagerungs-Oszillator-Prinzip. Im Grunderät wird die Ausgangsfrequenz von 50 kHz bis 50 MHz als Differenz einer festen, quarzgesteuerten Frequenz von 105 MHz und einer variablen, aber quarzgenau gesteuerten Frequenz von 105,05 bis 155 MHz hergestellt.

Dieses Verfahren hat den Vorteil, dass die Modulation, gleichwelcher Art, auf der festen Frequenz von 105 MHz und die Einstellung der Ausgangsfrequenz an dem variablen Oszillator erfolgen kann. Die Frequenz dieses Oszillators wird durch ein Frequenzsynthesesystem gesteuert, durch das variable Frequenzen mit der vollen Genauigkeit einer eingebauten Quarzsteuerung in 10 kHz—Frequenzabständen eingestellt werden können. Die Lücken zwischen den festliegenden 10 kHz—Einstellpunkten können durch einen abstimmbaren Präzisionsoszillator überdeckt werden, der eine Frequenzverschiebung der Einstellpunkte über den Bereich −3 kHz bis +13 kHz ermöglicht.

Um die Frequenzeinstellung so leicht wie möglich zu machen, wird das System mittels zweier Skalen gesteuert. Die erste Skala *A* hat 50 rastbare Einstellpunkte in 1 MHz Frequenzabstand von von 0...50 MHz; die zweite Skala *B* gibt 100 Rastpunkte mit 10 kHz Abstand zwischen den 1 MHz—Punkten der Skala *A*. Die dritte Skala *C* des abstimmbaren Präzisionsoszillators gibt die oben erwähnte kontinuierliche Verschiebung der Rastpunkte.

Zur Erzielung einer quarzgenauen Ausgangsfrequenz in 10 kHz—Abständen kann der abstimmbare Präzisionsoszillator abgeschaltet werden. Für Verwendungszwecke, die eine grössere kontinuierliche Frequenzverstimmung erfordern, kann die elektronische Rastung der Skala *B* und, wenn nötig, auch der Skala *A* aufgehoben werden, um kontinuierliche Verstimmbarkeit um 1 MHz von den 1 MHz Rastpunkten der Skala *A* allein zu erhalten, wenn sie "frei" ist.

Die Ausgangsfrequenz von 50 kHz wird in eingem sorgfältig durchkonstruierten Ringmodulator erzeugt. Die 105 MHz—Festfrequenz wird mit kleiner Ampli-

tude eingespeist, die im linearen Arbeitsbereich des Modulators liegt, so dass jede beliebige Modulationsart im Ausgangssignal des Ringmodulators getreu wiedergegeben wird.

Um die Vorteile der Flexibilität des Überlagerungssystems voll auszunutzen, wird die Festfrequenz durch leicht auswechselbare Modulationseinschübe gespeist. Bisher sind Modulationseinschübe für AM, Einseitenbandmodulation und FM lieferbar.

Die variable Frequenz wird dem Eingang mit viel höherem Pegel zugeführt, so dass die Amplitudenänderungen der variablen Frequenz im Ausgangssignal des Modulators nicht voll erscheinen.

Um den Ausgangssignalpegel unabhängig von Frequenz- und Belastungsänderungen konstant zu halten, wird das Ausgangssignal in einem Breitbandverstärker mit Ausgangsregelschaltung verstärkt. Dadurch wird die Ausgangs-EMK mit einer Genauigkeit von ±0,1 dB auf 1 V_{eff} konstant gehalten. Dieses Signal wird auf einem Instrument mit 0,3 dB absoluter Genauigkeit angezeigt und über einen Präzisions-Quellenwiderstand von 50Ω an den Hochleistungs-Ausgangsbuchsen abgegeben. Ein Einsteck-Dämpfungsregler mit neun 10 dB- und neun 1 dB—Stufen gibt eine genaue Dämpfung (±0.2dB) des 1V—Ausgangssignals, das auf Wunsch durch ein Netzwerk um weitere 20 dB reduziert werden kann. Die Streustrahlung des Gerätes ist unbedeutend und erlaubt volle Ausnutzung der niedrigsten Ausgangsleistung.

Der Frequenzbereich kann durch Einschübe bis 500 MHz erweitert werden.

EE 30 763 *für weitere Einzelheiten*

STREIFENSCHREIBER

Vertrieb durch: Aveley Electric Ltd, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex

(Abbildung Seite 119)

Aveley Electric Ltd hat vor kurzem ein verbessertes Modell des Rohde & Schwarz Enograph - Gleichspannungsschreibers, eines Kompensations-Schnellschreibers für lineare und logarithmische Anzeige, eingeführt.

Zu den interessanten Merkmalen des Enograph gehören eine sehr hohe Eingangsimpedanz von bis zu 10^{11}, völlig schwebender Eingang und zehn verschiedene durch Drucktaste einstellbare Streifengeschwindigkeiten. Die Papiergeschwindigkeiten stehen im Verhältnis 2 oder 3 zu 1 und können innerhalb eines Geschwindigkeitsbereiches von 10 mm/s bis 20 mm/h gewählt werden. Der Streifen kann auch durch einen externen Antrieb vorgeschoben werden; andererseits kann die externe Apparatur auch nach Drucktastenumschaltung vom Enograph angetrieben werden. Fernsteuerung für Umschaltung der Schreibstiftspannung und Papiertransport sind auch vorgesehen.

Der Enograph registriert alle durch eine Gleichspannung darstellbaren Variablen, wobei die hohe Eingangsimpedanz direktes Anlegen von Diodengleichrichter-, Diskriminator-, Regler- und Röhrenschaltungen, fotoelektrischen Vervielfachern u. dgl. ermöglicht.

Die vier Schreibeinrichtungstypen (Tinte, Kugelschreiber, Elektrode und Schreibstift) werden praktisch allen in der Registriertechnik auftretenden Forderungen gerecht.

Das Gerät hat ein äusserst stossfestes Schreibsystem und ist deshalb besonders für Versuchsanordnungen geeignet, die Erschütterungen ausgesetzt sind wie sie z.B. in Flugzeugen und Kraftfahrzeugen auftreten.

EE 30 764 *für weitere Einzelheiten*

STANDARD-BEZUGSSPANNUNG

Communications (Air) Ltd, Half Moon Street, Bagshot, Surrey

(Abbildung Seite 119)

Dieses netzbetriebene Gerät kann für Verwendungszwecke wie Speisung des Potentiometers in Schreibern eine Normalzelle ersetzen. Es gibt ungefähr 1 V mit einer Konstanz ab, die der einer Normalzelle vergleichbar ist, ermöglicht jedoch eine etwas grössere Stromentnahme (10 mA).

Der Betriebs-Temperaturbereich ist −20° ... 55°C und der Temperaturbeiwert ±0,001%/°C. Die Ausgangsänderung für 10% Eingangsschwankung ist 0,001%.

EE 30 765 *für weitere Einzelheiten*

MINIATUR-UKW-SENDER

R.E.E. Telecommunications Ltd, Telecomm Works, Market Square, Crewkerne, Somerset

(Abbildung Seite 119)

Der "Telecomm"-UKW-Sender TT/3 ist ein volltransistorisiertes Miniaturgerät für eine Festfrequenz im 70...100 MHz Band.

In einer quarzgesteuerten Schaltung finden sechs Transistoren Verwendung. Die eingebaute Quecksilberbatterie ermöglicht ungefähr 70 Stunden Dauerbetrieb. Die Senderleistung ist ungefähr 25 mW, hängt aber von der Frequenz ab.

Bei Abmessungen von 140 × 76,2 × 32 mm wiegt er 284 g. Üblicherweise wird ein dynamisches Mikrofon sowie eine Viertelwellen-Stab- oder -Litzenantenne mitgeliefert.

Ein Miniaturempfänger TR/3 ähnlicher Abmessungen mit quarzgesteuerter Doppelüberlagerungsschaltung wird in Kürze für Verwendung mit diesem Sender lieferbar werden. Trotzdem die beiden Geräte für den Nahverkehr in Docks, Bauten oder Werksanlagen bestimmt sind, wurden in Tests zufriedenstellende Verbindungen über Entfernungen von ungefähr 8 km hergestellt.

EE 30 766 *für weitere Einzelheiten*

MESSWERTGEBER

Southern Instruments Ltd, Frimley Road, Camberley, Surrey

(Abbildung Seite 120)

Mit der Einführung von vier neuen Gebern wurde das für das Southern-FM-System zur Verfügung stehende vielseitige Fertigungsprogramm erweitert.

Der Niederdruckgeber G 304 mit hoher Überlastbarkeit ist ein induktiver Typ, der wassergekühlt werden kann. Die Membranauslenkung wird durch einen Anschlag begrenzt, wodurch der Geber Drücken bis zu 70 kg/cm² widerstehen kann. Die Grenze der Membranauslenkung, und damit die Höchstleistung, wird bei viel geringeren Drücken erreicht. Der Geber ist für jeden Bereich zwischen 0 und 0,7 kg/cm² und zwischen 0 und 7 kg/cm² lieferbar und zur Messung niedriger Drücke in Systemen geeignet, in denen hohe Stossdrücke vorkommen.

Der Druckgeber G 302 ist ein induktiver Typ mit bündiger Membran. Damit werden durch stehendes Volumen und Durchgangsfrequenz in Gebern mit eingezogener Membran auftretende Probleme vermieden und Montage ohne Volumenänderung des zu messenden Mediums ermöglicht. Lieferbar für jeden Bereich zwischen 0 und 0.7 kg/cm² und zwischen 0 und 703 kg/cm². Proportionalität und Hysterese sind besser als ±1% des vollen Bereiches. Der Geber, der bis zu 150°C ohne Kühlung arbeiten kann, wird durch 100%ige Überlastung nicht beschädigt. Er hat einen hohen Frequenzgang und kann statisch geeicht werden.

Der Drehschwingungsgeber G128 wird jetzt in verbesserter Ausführung als Typ G 318 geliefert. Dieser induktive Geber hat weder Schleifringe noch bewegliche Kontakte. Die neue Ausführung ist für höhere Geschwindigkeiten besser geeignet und bietet grössere Zuverlässigkeit beim "Auslaufen" und bei nichtaxialen Zuständen. Der Ausgang ist im Bereich ±4° der Winkelbewegung direkt proportional. Er kann unter Benutzung der mitgelieferten Lehre an der Messstelle statisch geeicht werden.

Die Gruppe wird durch den kapazitiven Druckgeber G 319 vervollständigt, der ohne Kühlung in Temperaturen bis zu 500°C eingesetzt werden kann.

EE 30 767 *für weitere Einzelheiten*

FREQUENZMESSER

elomechanics Ltd, Brockenford Lane, Totton, Southampton, Hampshire

(Abbildung Seite 120)

Dieser direkt anzeigende Frequenzmesser kann jede beliebige diskrete Frequenz zwischen 1 kHz und 3 GHz erzeugen und messen. Die Stabilität hängt von den gewählten Quarzen ab und liegt zwischen $2 \cdot 10^{-6}$ und $4 \cdot 10^{-10}$. Geignet zum Treiben und Prüfen von Einseitenbandsystemen, Erregung magnetischer Kernresonanzen als Primärstrahler-Navigationshilfe, Labornormal für wissenschaftliche, industrielle und Lehrlabors. Anschlüsse für externe Einschubzähler sind vorgesehen.

Der T.D.1 ist tragbar, und die erste Ausführung hat ein eingebautes Quarz, das nach einer Stunde eine Genauigkeit von $2 \cdot 10^{-8}$ hat. Der Innenwiderstand ist 75Ω, die Ausgangsspannung 100 mV für die Grundfrequenz, die Eingangsspannung für Grundfrequenz und Oberwellen 1 mV und der Nebenwellenpegel −80 dB. Spannungsänderungen, Röhrenverschlechterung und mechanische Erschütterungen beeinflussen weder Frequenz noch Phase nennenswert.

EE 30 768 *für weitere Einzelheiten*

MIKROWELLEN-MESSENDER

Schomandl K.G., München 8, Belforststrasse 6-8, Germany

(Abbildung Seite 120)

Die Mikrowellen-Frequenzdekade FD3 wird als Teil des umfangreichen Fertigungsprogrammes für Frequenzmessanlagen von dieser Firma hergestellt.

Für die Normalfrequenz wird ein 100 kHz—Quarzgenerator benutzt; der Ausgang ist in 100 kHz Intervallen phasenstarr zu diesem Normal. Zwischenwerte können im Grundbereich von 300...1000 MHz mit 300 Hz Genauigkeit eingestellt werden. Oberwellen können zur Erweiterung des Bereiches bis zu 12,6 GHz erzeugt werden.

Eine Kombination des FD3 mit einer Frequenzdekade ND5 und einer Feindekade NDF1 gibt eine Genauigkeitserhöhung durch phasenstarre Einstellung in 100 Hz—Schritten. Der zusätzliche Fehler für kontinuierliche Einstellung im Bereich 300...1000 beträgt dann nur ±0,1 Hz.

Die Ausgangsleistung im Grundbereich ist 1 mW und die Empfindlichkeit bei Verwendung als Frequenzmesser 100 μW. Schwebungsanzeige mit Kopfhörer oder "Magischem Fächer."

EE 30 769 *für weitere Einzelheiten*

ELEKTROSTATISCHE MESSGERÄTE MIT GRENZWERTMELDER

Nalder Bros. & Thompson Ltd, 97 Dalston Lane, London E.8

(Abbildung Seite 120)

Diese neue Instrumentserie wurde entwickelt, um der theoretischen Leistung dieser Messgerättypen so nahe wie möglich zu kommen. Das dadurch zur Verfügung stehende höhere Drehmoment ermöglichte die Herstellung einer Reihe elektrostatischer Voltmeter mit Grenzwertmelder.

Um die Instrumentkontakte, die von aussen für Über- und Unterspannung einstellbar sind, stromlos zu halten, werden sie in die Gitterschaltung eines zugehörigen Röhrenverstärkers gelegt. Dadurch fliesst der Hauptauslöse- oder Alarmstrom durch Einsteck-Magnetspulenrelais.

Die Betriebsgrenzen für diese Instrumente sind 100 V bis 15 kV.

Die Abbildung zeigt ein 10 kV—Instrument mit Meldeverstärker.

EE 30 770 *für weitere Einzelheiten*

TANTALKONDENSATOREN MIT FESTELEKTROLYT

Texas Instruments Ltd, Dallas Road, Bedford

„tan-TI-cap"-Kondensatoren Typ SCM sind in 203 Standardkombinationen von Kapazität und Spannung von 1...330 μF mit ±10% und ±20% Toleranz und für 6, 10, 15, 20, 25 und 35 V Nenn-Gleichspannung lieferbar und werden in vier Gehäusegrössen gebaut.

Das Pflichtenblatt gibt Betrieb mit Nennspannung von −55°C...+85°C und mit zwei Drittel der Nennspannung bei 135°C; Betriebsstabil von −80°C...+125°C. Diese Hochleistungskondensatoren werden 100% auf Reststromstabilität (Rauschen) geprüft und haben bei Betrieb mit Spitzenspannung eine Ausfallrate, die besser als 2×10^{-5} ist.

Unter anderen Kennzeichen sind zu nennen kleinste industrielle Gehäuseabmessungen, Dauersperrspannungsvermögen, grosse Schwingungs- und Stossfestigkeit und äusserst korrosionsfeste Ausführung. Die versteiften axialen Anschlussdrähte ohne externe Dichtungsabschlüsse erlauben einfaches Einbauen und scharfes Biegen ohne Brechen.

Diese Kondensatoren haben feste Elektrolyten und gesinterte Tantalanoden mit einem Tantalpentoxydfilm höchster Vollständigkeit und maximaler Stärke für jede der Spannungsklassen. Durch diese Konstruktion wird die Beibehaltung ihrer Originalcharakteristiken über unendlich lange Lagerzeiten gewährleistet, da sie weder lecken noch dehydrieren können und nicht temperaturempfindlich sind.

EE 30 771 *für weitere Einzelheiten*

IMPULSGEBER

Solartron Laboratory Instruments Ltd., Cox Lane, Chessington, Surrey

(Abbildung Seite 121)

Der Solartron Dekaden-Impulsgeber GO 1005 ist für genaue Bestimmung von Durchlasscharakteristik und Einschwingvorgängen in Verstärkern und Netzwerken oder Prüfung der Frequenz- und Amplitudengrenzen von elektronischen Zählern geeignet. Das Gerät gibt positiv oder negativ gehende Rechteckimpulse mit Amplituden bis zu 100 V und Tastfrequenzen von 10 Hz...1 MHz ab.

Grob- und Feineinstellung der Impulsdauer, Tastfrequenz und Signalverzögerung erfolgen mittels drei konzentrischer Reglersätze mit beleuchteten Skalen; die erforderlichen Ausgangsbedingungen können mit Hilfe des eingebauten Amplitudenmonitorinstrumentes einfach und genau eingestellt werden.

Die Signalverzögerung in Bezug auf einen 10 V—Vorimpuls kann genau wie die Rechteckimpulsdauer über den Bereich von 250 ns...100 ms eingeregelt werden.

Bei Betrieb im Doppelimpulsverfahren fällt die Vorderflanke des ersten Impulses mit dem Vorimpuls zusammen, und die Vorderflanke des zweiten identischen Impulses beginnt nach Ablauf der eingestellten Signalverzögerung.

Ein verzögerter Vorimpuls steht ungefähr 250 ns nach dem Vorimpuls als Triggerausgang zur Verfügung, der so eingestellt werden kann, dass er mit der Vorderflanke des Hauptimpulses zusammenfällt.

EE 30 772 *für weitere Einzelheiten*

ZEITMESSGERÄT

Dynatron Radio Ltd, Maidenhead, Berkshire

(Abbildung Seite 121)

Das Zeitmessgerät wurde in erster Linie als Schaltgerät für die Untersetzer der Serie 1009 entwickelt, denen die erforderliche Stromversorgung entnommen werden kann. Die Hauptaufgabe des Gerätes ist Abschaltung des Untersetzers nach vorgewählter Zeit oder vorgewählter Anzahl von Impulsen und Ablesung der Gesamtzählung und Gesamtzeit von geeichten Dekadenzählrohren.

Typ N108 hat eine Zeitkapazität von 100 000 s und mit dem Untersetzer eine Zählkapazität von 1 000 000 Vorgängen. Das Gerät hat den weiteren Vorteil, dass der Untersetzer mit einer Höchstauflösung von 1 μs arbeiten kann, wodurch seine maximale Zählgeschwindigkeit ausgenutzt werden kann.

Die Abbildung zeigt das Zeitmessgerät mit dem Untersetzer 1009 E.

EE 30 773 *für weitere Einzelheiten*

MINIATURPOTENTIOMETER

Miniature Electronic Components Ltd, The Lye, St. Johns, Woking, Surrey

(Abbildung Seite 121)

Dieses eingängige Miniaturdrahtpotentiometer wird unter Lizenz der Technology Instrument Corporation of America hergestellt und wurde besonders für Flugzeuge und Flugkörper entwickelt. Der grösste Durchmesser ist 12,7 mm und die Gesamtlänge 29 mm.

Es kann bei 80°C mit 1,5 W belastet werden und hat einen Temperaturbereich von −55°C...+150°C. Zehn Standardwerte von 50Ω bis 50 kΩ sind lieferbar.

EE 30 774 *für weitere Einzelheiten*

REGISTRIERENDES pH-METER

Analytical Measurements Ltd, Donne Buildings, The Quadrant, Richmond, Surrey

(Abbildung Seite 121)

Das Gerät hat einen elektronisch modulierten Verstärker, der Netzschwankungen kompensiert und ist mit Standardröhren bestückt. Ein Streifenschreiber bildet die Frontplatte des Gerätes und nimmt eine 19 m—Messstreifenrolle auf, die bei einer Geschwindigkeit von 25,4 mm/h 31 Tage reicht. Durch Wechselgetriebe können andere Vorschübe bis zu 40,6 cm/h eingerichtet werden. Verbindungen für Einschaltung eines Platin-Widerstandsthermometers für automatische Temperaturkompensation sind vorgesehen. Der Streifenvorschub kann von der Frontplatte aus abgeschaltet werden, so dass das Instrument als anzeigendes pH-Meter benutzt werden kann. Die analytische pH-Messzelle besteht aus einer Glaselektrodenkette, die vollkommen durch Polyäthylen geschützt ist.

EE 30 775 *für weitere Einzelheiten*

MIKROWELLENRÖHREN

Standard Telephones & Cables Ltd, Connaught House, Aldwych, London W.C. 2

(Abbildung Seite 121)

Die Erweiterung der bestehenden Serie durch zwei neue H-Wellen-Oszillatorröhren ermöglicht Überstreichung des Bereiches zwischen 5850 und 7770 MHz mit vier Röhren. Jede Röhre hat einen elektronischen Abstimmbereich von ±8,5 MHz und eine Mindestausgangsleistung von 800 mW. Sie haben ausgezeichnete Frequenzkonstanz, niedrige Betriebsspannungen und werden durch Strahlung ausreichend gekühlt.

Die Röhrenbezeichnung ist V261C/1M (5850...6350 MHz) und V266G/1M (6350...6850 MHz).

Eine fünfte Röhre für H-Wellen, die V265A/1M, kann nur mechanisch abgestimmt werden und gibt über den Bereich 5850...7100 MHz mindestens 200 mW ab.

Eine neue geschwindigkeitsmodulierte Oszillatorröhre des koaxialen Leitungstypes trägt die Bezeichnung V231C/1K und ist hauptsächlich für S-Band Radar bestimmt. Die Röhre überstreicht den Frequenzbereich zwischen 3060 und 3180 MHz mit einer Mindestausgangsleistung von 40 mW. Sie ist für Verwendung mit Hohlraum Typ 495-LVA-252 gedacht, der mit dem Hohlleiterausgang WG 10 einen kompakten Baustein bildet. Die Röhre kann, wenn nötig, über einen Bereich von mindestens ±8 MHz elektronisch abgestimmt werden.

Die abgebildete Wanderfeldbegrenzerröhre W9/BE überstreicht einen Frequenzbereich von 2500...4100 MHz, hat eine Kleinsignalverstärkung von 15 ±3 dB und eine Sättigungsleistung von −7 ...−12 dBm. Die Röhre ist als Überlastungsschutz in Geräten gedacht, in denen ein grosser Eingangsleistungsbereich erwartet wird und gibt auch nützliche Verstärkung für kleine Signale.

Ein Fokussiersolenoid aus Aluminiumfolie mit eingebauten koaxialen HF-Eingangs- und Ausgangsverbindungen (Typ 495-LVA-007) ist lieferbar.

EE 30 776 *für weitere Einzelheiten*

Zusammenfassung der wichtigsten Beiträge

Elektrolumineszenz: Ihre Kennlinien und Anwendungsgebiete von D. H. Smith

Zusammenfassung des Beitrages auf Seite 68-72

In Teil 1 des Beitrags werden die Lichtkennlinien elektroluminöser Zellen beschrieben, die durch Sinuswellen und Spannungsimpulse erregt werden. Das Wesen der Elektrolumineszenz wird kurz diskutiert. In Teil 2 werden die vielen Verwendungszwecke besprochen. Elektroluminöse Lichtquellen können z.B. als Lichtquellen und für Informations sichtanzeige benutzt werden; aus einer Kombination von elektroluminösen und Fotoelementen können Lichtverstärker zusammengestellt werden, und eine Anordnung sehr kleiner elektroluminöser Zellen kann einen sehr dünnen Bildschirm für Fernseher bilden.

Kondensator-Impulsgeber von E. R. Wooding

Zusammenfassung des Beitrages auf Seite 73-76

In dem Beitrag wird eine Kurvenschar gegeben, die die Berechnung von Form, Strom, Leistung und Dauer eines Impulses erleichtert, der durch Entladung eines Kondensators durch einen induktiven Verbraucher wie z.B. eine Glimmlampe oder Schnellblitzquelle entsteht.

Selektiver RC-Verstärker mit Transistoren von R. Hutchins

Zusammenfassung des Beitrages auf Seite 84-87

In diesem Beitrag wird die Verwendung von Phasenschiebernetzwerken in Transistor-Schaltungen untersucht. Der die Reihen- und Parallelschaltung enthaltende Wien-Brückenarm wird dazu benutzt, einen Oszillator und einen selektiven Verstärker zu bilden. Der beschriebene selektive Verstärker hat kontinuierlich regelbare Selektivität und Abstimmung bei konstanter Verstärkung.

Diffundierte Legierungstransistoren von E. Wolfendale

Zusammenfassung des Beitrages auf Seite 88-93

In diesem Beitrag wird gezeigt, dass die üblichen Herstellungsverfahren für Legierungstransistoren im UKW-Bereich keiner weiteren Ausbeutung fähig sind, und Herstellungsverfahren für diffundierte Legierungstransistoren und die Gründe für ihre Vorteile werden beschrieben.

Die Leistung greifbarer diffundierter Legierungstransistoren und einige typische Schaltungen werden gegeben.

Abschliessend wird der wahrscheinliche Entwicklungsbereich für diffundierte Legierungstransistoren besprochen und festgestellt, dass Typenserien bestehen, die den ganzen Bereich überstreichen und mit Ausnahme vom Betrieb im UHf-Bereich und Leistungsausstrahlungen Röhren ersetzen können.

Fliessbetten als temperaturkonstante Umhüllung beim Prüfen elektronischer Bauelemente von H. Sutcliffe

Zusammenfassung des Beitrages auf Seite 94-95

Das Problem, elektronische Bauelemente während der Messung ihrer Kennwerte auf konstanter Temperatur zu halten, wird besprochen. Eine Alternative zu herkömmlichen Methoden ist die Fliessbettechnik, bei der die temperaturkonstante Umhüllung aus einem Bett fester Teilchen besteht, die in einem aufwärts gehenden Luftstrom schweben. Konstruktion und Leistung eines kleinen Fliessbettes wird beschrieben und die Schlussfolgerung gezogen, dass das Fliessbettverfahren grosse Vorteile hat.

Ein Mehrzweck-Rechnerbaustein von C. B. Taylor

Zusammenfassung des Beitrages auf Seite 96-99

Der beschriebene Baustein ist im wesentlichen ein Kurvenumformer mit einem Röhrenpaar mit gemeinsamem Kathodenwiderstand, der in Verbindung mit logischen Tor-Schaltungen vielfach als Grundbaustein für ein Rechnersystem Verwendung finden kann. Der Hauptzweck der Entwicklung war die Konstruktion einer rationellen binären Zählstufe mit Transistor-Dioden-Logik; unter den vielen anderen Verwendungsmöglichkeiten des Bausteins wären aber auch Impulsformer, einfache Umformer, Verzögerung mit umgeformten zweiphasigen Ausgängen, bistabile Elemente und freilaufende Rechteckwellengeneratoren zu nennen.

Ein Bandfilter mit veränderlicher Bandbreite von J. Holland

Zusammenfassung des Beitrages auf Seite 100-105

Eine Methode, die in einem LC-Filter mit nur einem Spulensatz mehrere Bandbreiten ergibt, wird beschrieben. Die Konstruktion eines typischen Filters, sowie Kurven der gemessenen Dämpfungswerte sind angegeben.

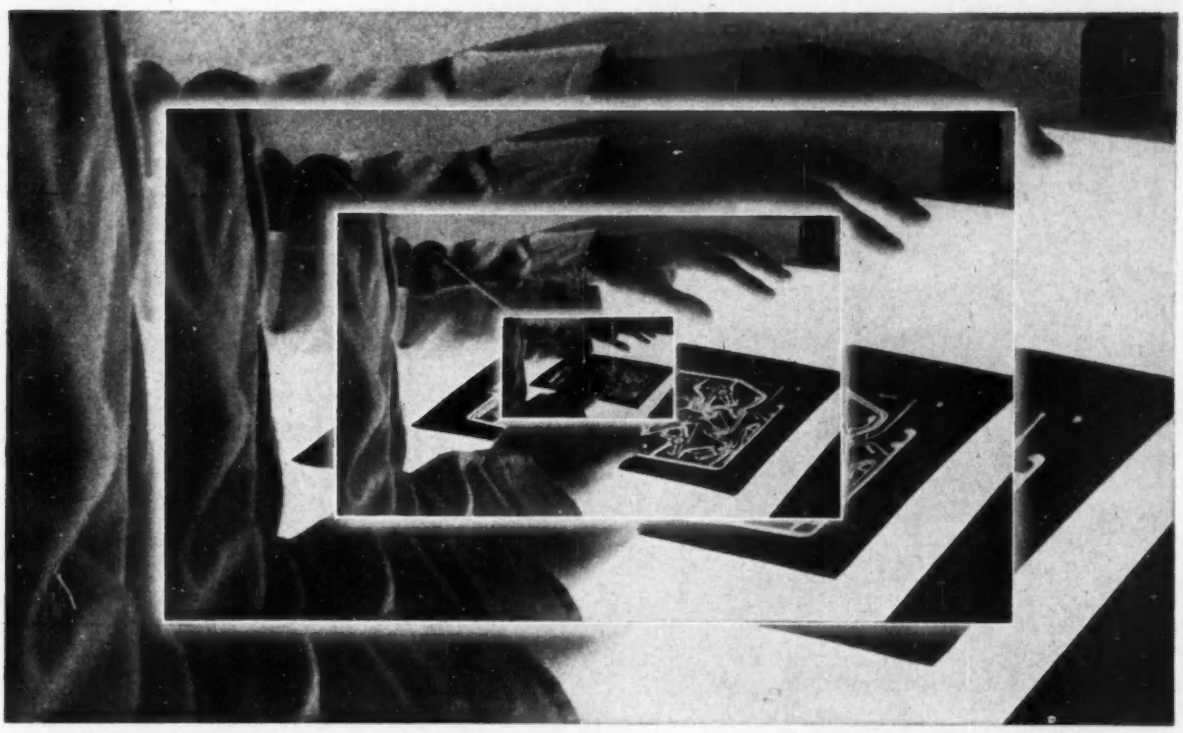
Schnelle Methode zur Berechnung von Butterworth Filtern von J. S. Bell und P. G. Wright.

Zusammenfassung des Beitrages auf Seite 106-108

Der Butterworth-Filtertyp hat für verschiedene Zwecke verschiedene Vorteile über herkömmliche Filtertypen. Diese Vorteile werden beschrieben, eine Berechnungsmethode formuliert und eine praktische Konstruktion besprochen, bei der die angegebene Methode benutzt wird.

EE 30 125 *for further details*

for better printed circuits — and quicker prototypes



BRIBOND EXPAND DESIGN UNIT

There are many styles of printed circuit but, so far, no standards. Yet the ideal printed circuit must conform to certain recognised factors. This means better and still better design. And the reward is not only greater ease of assembly and more efficient operation but economies in production costs.

Recognising this need for closer design/production co-ordination, Bribond have expanded their design service to manufacturers. Those who use this service have all the latest advances in circuit technique incorporated in their designs. They will always be just a little ahead. They may even pay less.

Why not consult Bribond about your next circuit design at the planning stage? Bribond manufacture all forms of the printed circuit: gold, silver or rhodium plating, double-sided circuits, flexible circuits, flush circuits, and resistance circuits. Component notation, chemical milling and all forms of subsequent machining operations can be undertaken.

B P C BRIBOND **printed circuits**

A.I.D. APPROVED

BRIBOND LTD., BURGESS HILL, SUSSEX. *Telephone:* Burgess Hill 85611

AYLING INDUSTRIES GROUP

The Highest Sensitivity
and the lowest noise.....

Advanced electronic research by Hitachi technicians has now resulted in the development of a superb frame grid type twin triode (6R-HH8) with excellent high gain and low noise characteristics. As a component of the tuner, the 6R-HH8 ensures an excellent picture with a remarkable degree of definition.

fig. 1 Gain characteristics

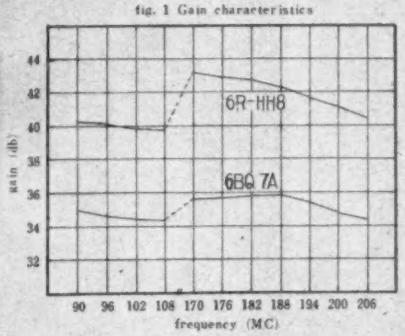
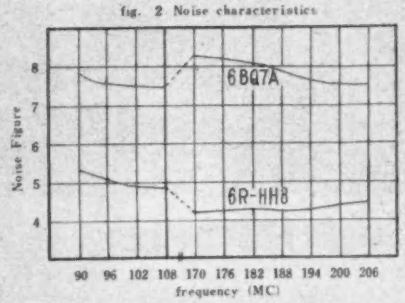
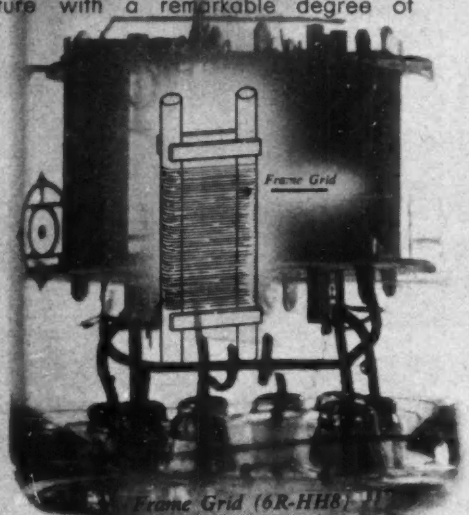


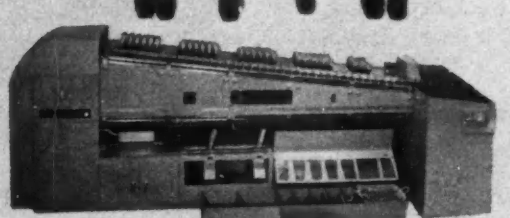
fig. 2 Noise characteristics





Frame Grid (6R-HH8)

Hitachi also produces other receiving tubes and components for television which, when used together with the new 6R-HH8, cannot fail to earn any maker a market reputation even better than he currently enjoys.



Automatic tube testing equipment

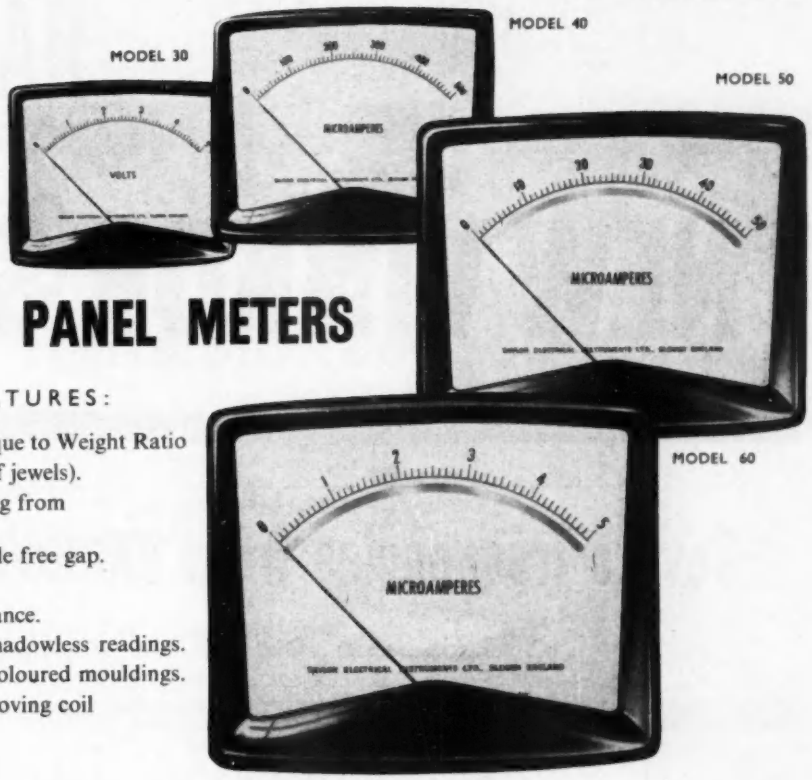
Hitachi, Ltd.
Tokyo Japan
Cable Address: "HITACHY" TOKYO

EE 30 127 *for further details*

NEW!

Vista

CONTEMPORARY PANEL METERS



OUTSTANDING FEATURES:

- ★ Centre pole movement. High Torque to Weight Ratio
- ★ Extreme Robustness (Shock proof jewels).
- ★ Very high sensitivities commencing from 5 Microamps.
- ★ Exceptional coil clearance. Trouble free gap.
- ★ Inherent Magnetic Shielding.
- ★ Modern design, very neat appearance.
- ★ Wide, Open scales resulting in shadowless readings.
- ★ Selection of sizes, and choice of coloured mouldings.
- ★ Available with moving iron, or moving coil movements.
- ★ Accuracy to B.S. 89/54.
- ★ Competitive prices.

100,000 o.p.v. !

Model '100A' TAYLORMETER

HIGHEST SENSITIVITY IN THE WORLD

13 STAR FEATURES

- ★ Supersensitive.
- ★ Automatic Mechanical Overload Cut-out.
- ★ Reverse Polarity Facility.
- ★ Lowest current reading—0.2μA.
- ★ 10 Microamps full scale.
- ★ Highest current reading—10 Amps DC.
- ★ Lowest resistance reading—0.5 ohms.
- ★ Highest resistance reading—200 Megohms self contained.
- ★ Lowest voltage reading—10 mV DC.
- ★ Highest voltage reading—25 KV DC.
- ★ Very Robust—suitable for everyday use.
- ★ Accuracy (2% DC. 3% AC. Ohms 5%).
- ★ Portable.

TRADE PRICE £26.15.6

Complete with Instruction Manual and Interchangeable test prods and clips. High quality leather case, if required, **£2 10s. 0d.**

H.V. Probe for 25 Kv ... **£4 0s. 9d**

Write for full details and free catalogue

TAYLOR ELECTRICAL INSTRUMENTS LIMITED

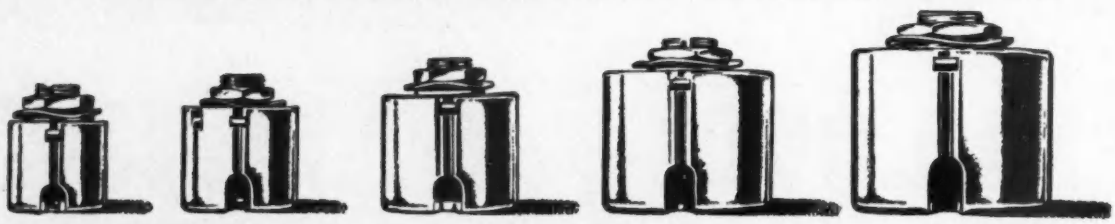
MONTROSE AVENUE, SLOUGH, BUCKS. Telephone: SLOUGH 21381

Member of the METAL INDUSTRIES GROUP OF COMPANIES

EE 30 128 *for further deatils*

NEW VINKOR SERIES

Covers frequencies from 100 Kc/s to 2 Mc/s



A new series of Vinkor adjustable pot cores has been developed by Mullard for use in the frequency range 100 kc/s to 2 Mc/s. This series is in addition to the highly successful group already widely used for frequencies between 1 kc/s and 200 kc/s.

The world's most efficient pot core assembly, the Mullard Vinkor gives a choice of 3 permeabilities and has exceptionally high performance and stability. Write today for full details of the wide range of Vinkors now available.

Mullard VINKOR

ADJUSTABLE POT CORE ASSEMBLIES

MULLARD LTD., COMPONENT DIVISION, MULLARD HOUSE, TORRINGTON PLACE, W.C.1.
MC1

SILVER STAR square section CAPACITORS

for transistorised circuits

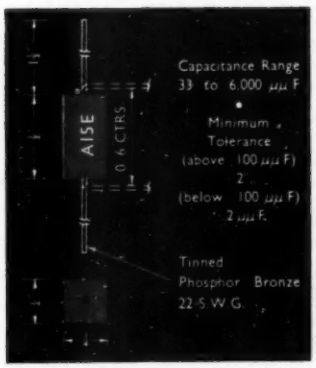
Something new in silvered mica capacitors — new in the Silver Star range!

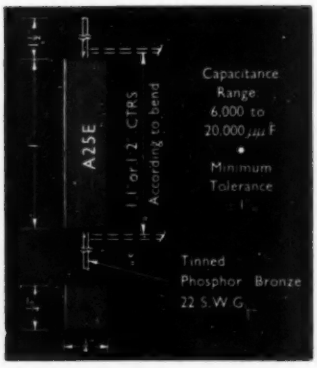
Designed specially for transistor circuitry, these miniature square-section capacitors are particularly useful when the component density is high.

And they are ideal for printed circuits, for they can be cemented to the circuit board — a big advantage when acceleration forces are high.

Two sizes (A15E and A25E) together cover the capacitance range from 33 to 20,000 μμF. For values above 6,000 μμF the capacitance tolerance can be as close as ±1 per cent.

- **Square section**
- **Miniature size**
- **Ideal for printed circuitry**
- **50 volt rating**
- **Fired construction for maximum long-term stability**
- **Synthetic resin encapsulated**
- **Ideal for "high g" applications**
- **Silver Star © quality**





Full technical information available on request.

One of the specialised products of

Johnson Matthey

JOHNSON, MATTHEY & CO., LIMITED
73-83 HATTON GARDEN, LONDON, E.C.1
Telephone: Holborn 6989

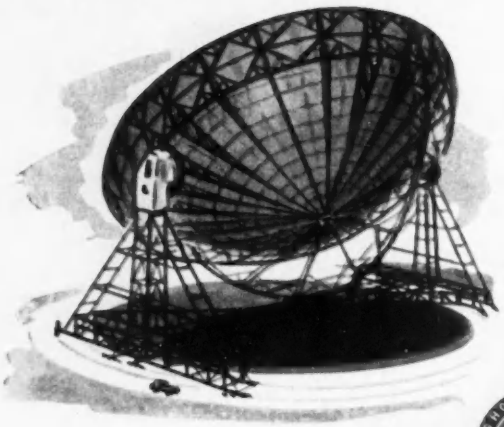
Vittoria Street, Birmingham, 1. — *Telephone: Central 8004*
75-79 Eyre Street, Sheffield, 1. — *Telephone: 29212*

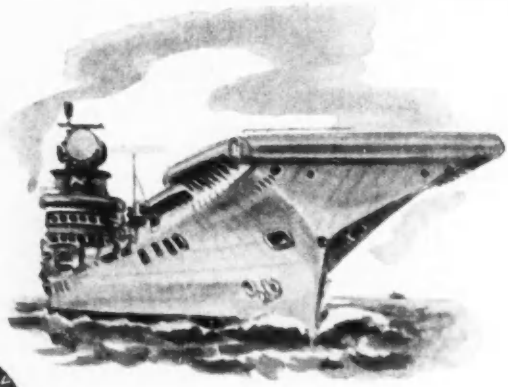
EE 30 130 *for further deatils*

The

EDDYSTONE '770' V·H·F & U·H·F *RECEIVERS*

For Service & Professional Communications

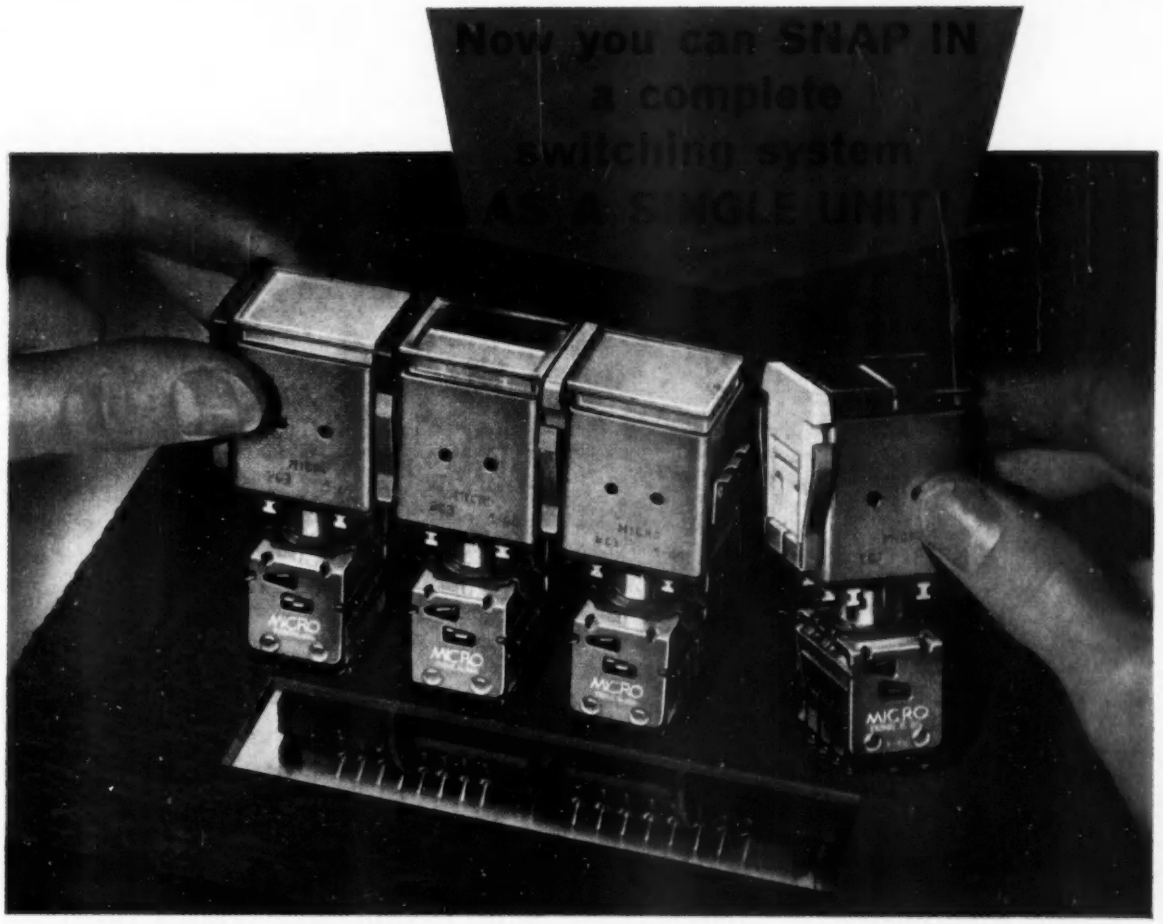




Superbly engineered and of advanced design, the two models offered possess excellent electrical characteristics and are robustly constructed for service in any climate. The "770R" has continuous AM/FM coverage from 19 Mc/s to 165 Mc/s; the "770U" from 150 Mc/s to 500 Mc/s. Both incorporate six-position turret tuning assemblies of unique design and giving high reliability. Illustrated literature with full information and performance curves sent on request.

MANUFACTURERS

STRATTON & CO. LTD · BIRMINGHAM 31



Honeywell Series 2 Lighted Pushbutton Switches

save space on the panel

Pushbutton, lighted and labelled screen and switch as a single unit . . . this Series 2 development is an entirely new concept in micro switch design. The illuminated screen *is* the pushbutton. It can be in any of five colours, or combinations of any two. Four-pole switching can be provided on a single pushbutton. The panel space saving potential of Series 2 is tremendous. Units can be mounted singly, or combined in rows or columns simply by clipping together and snapping into the panel as a group. Installation is easy in any type of panel—graphic flow panels, test panels, annunciator panels and panels associated with data processing systems, business machines, computers and scientific instruments.

WRITE OR SEND THE COUPON TODAY
Honeywell Controls Limited,
Ruislip Road East, Greenford,
Middlesex. Waxlow 2333

I am interested in your new Series 2 development. Please send me Catalogue 67A.

Name .....

Company .....

Position .....

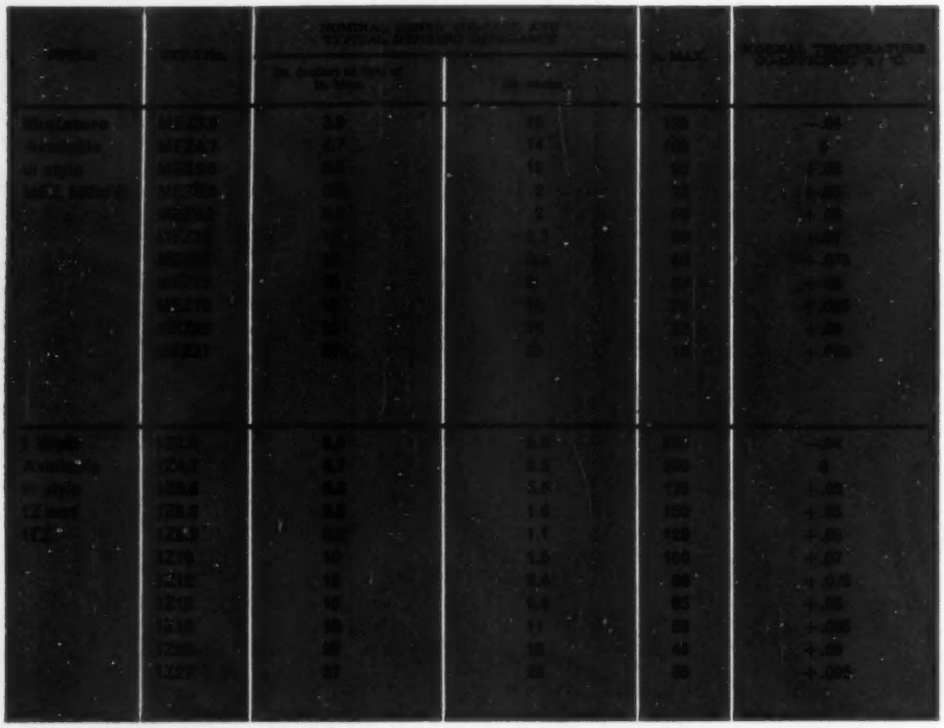
Address .....

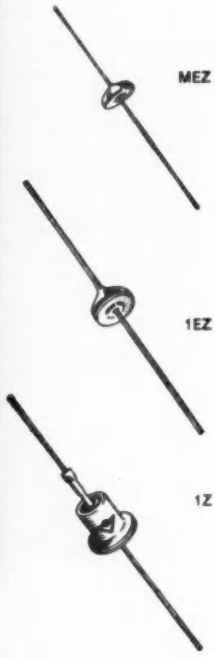
EE

Sales Offices in the principal towns and cities in the United Kingdom and throughout the world.

Honeywell

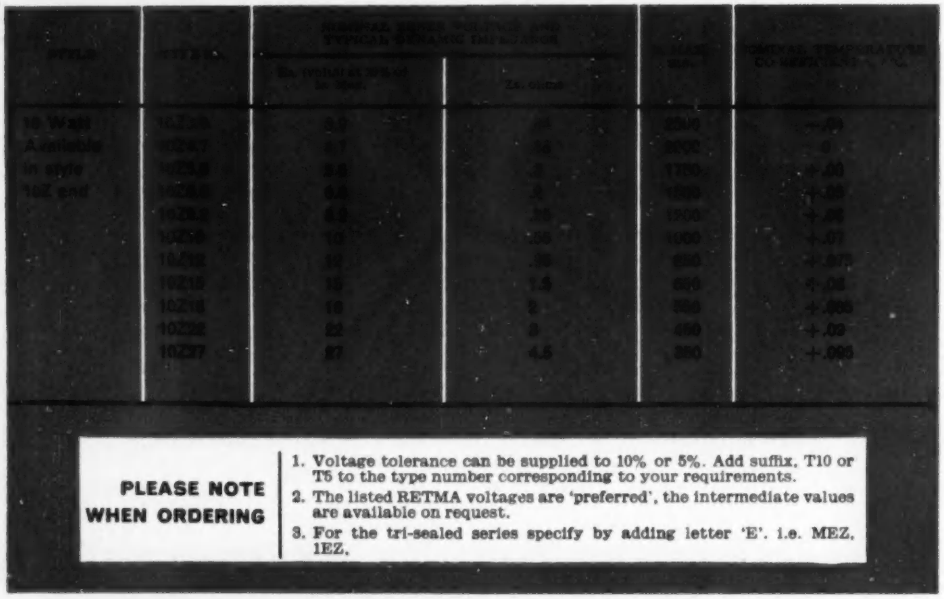
H HONEYWELL *First in Micro Switches*





ZENER DIODES

IMMEDIATE DELIVERY FOR YOUR PROTOTYPES



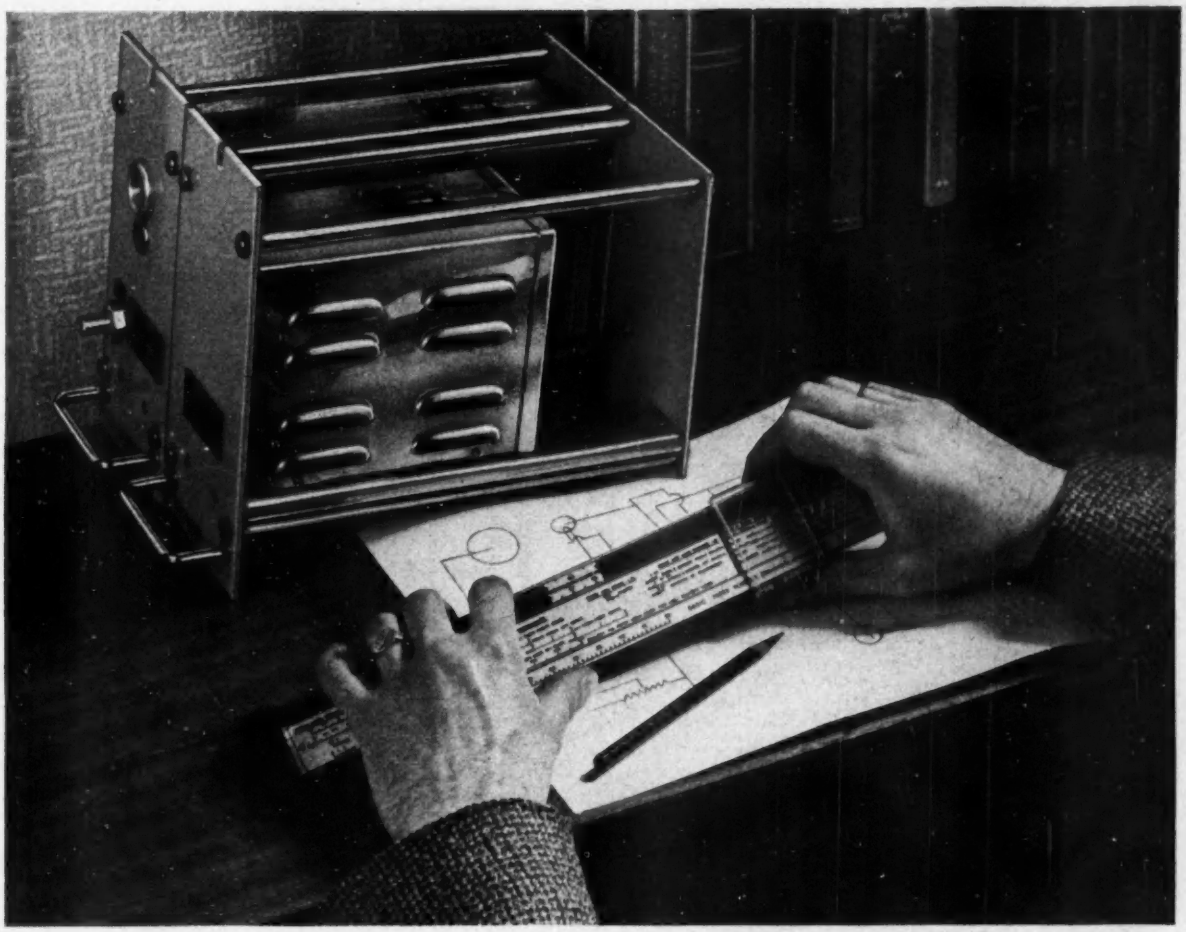
PLEASE NOTE WHEN ORDERING

1. Voltage tolerance can be supplied to 10% or 5%. Add suffix, T10 or T5 to the type number corresponding to your requirements.
2. The listed RETMA voltages are 'preferred', the intermediate values are available on request.
3. For the tri-sealed series specify by adding letter 'E'. i.e. MEZ, 1EZ.

INTERNATIONAL RECTIFIER COMPANY

(GREAT BRITAIN) LIMITED · OXTED · SURREY · Oxted 3215

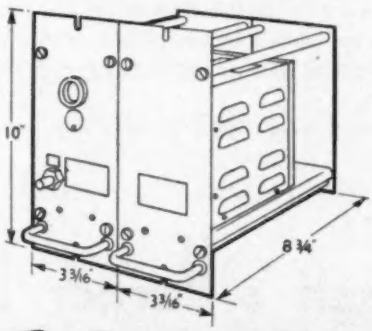
Associate company of International Rectifier Corporation U.S.A. and The Metal Industries Group, Great Britain.



a new concept in high-stability frequency sources

The latest range of compact, high-stability frequency sources by STC represents considerable progress in size, weight and price reduction without sacrifice of ageing characteristics, short-term stability or temperature dependence.

Illustrated is the 90 LQU 802B comprising type 57 LQU 423 Quartz Crystal Unit and Temperature Control Unit Type 1LQU 101B:—



STABILITY	± 4 in 10^{10}
AGEING	1 in 10^{9} per day
DIMENSIONS	Two Units 10 in. x 8⅛ in. x 3⅜ in.

Full details of all units in the range available on request from —

STC COMPONENTS GROUP

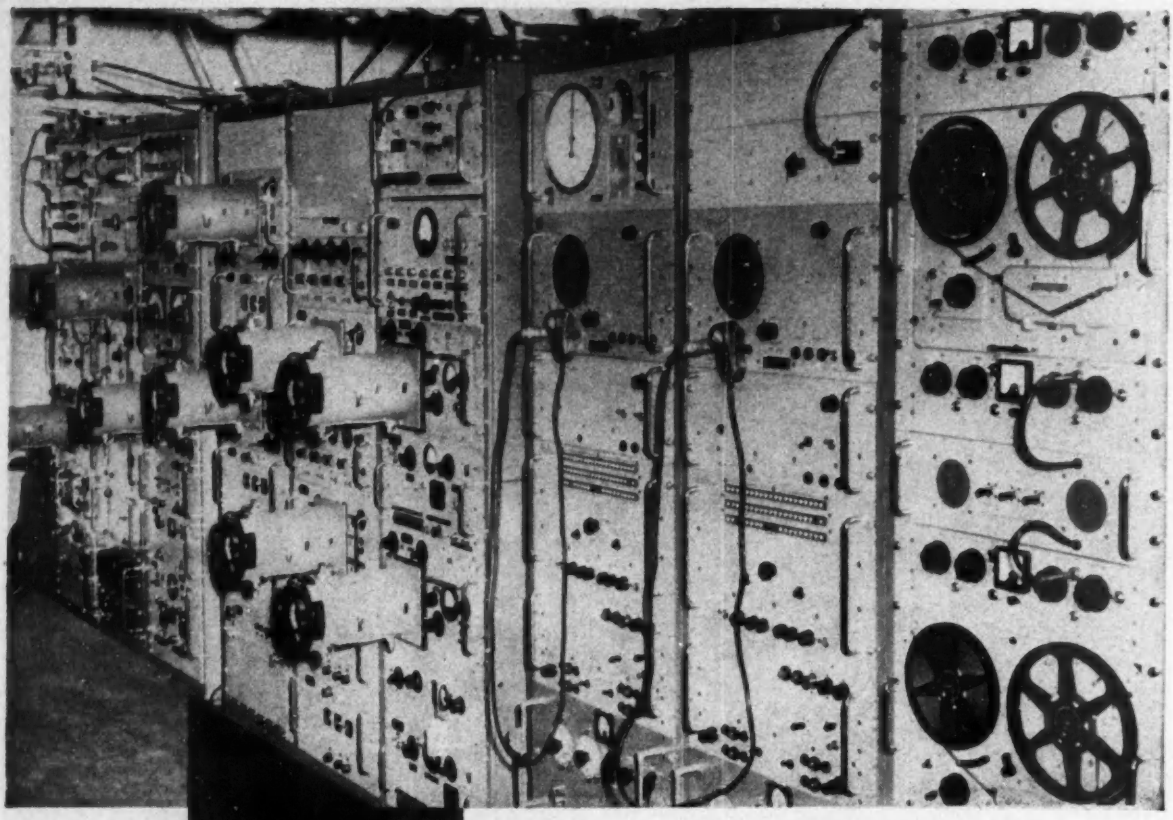
61/3MQ

Standard Telephones and Cables Limited

Registered Office: Connaught House, Aldwych, London W.C.2

QUARTZ CRYSTAL DIVISION · HARLOW · ESSEX

EE 30 134 *for further details*



The Atomic Energy Authority use Hassett & Harper Cabinets

The specialised equipment shown in our illustration is housed in Hassett & Harper Cabinets at one of the Authority's Establishments.

We are proud to include the Authority in our list of distinguished customers, and to have co-operated with their engineers in this project.

Whoever our customer may be, we operate with a dual aim : to supply his exact requirements and to maintain Hassett & Harper standards at a consistently high level. From initial consultation, through detailed development to completion of a precision-made job delivered on time, our engineers will display lively and interested co-operation.

The standard range of Hassett & Harper Cabinets, variable in a wide combination of ways, meets most requirements, while a custom-built 'special' can meet any requirement. Ministry K114 Standard is regularly adhered to.

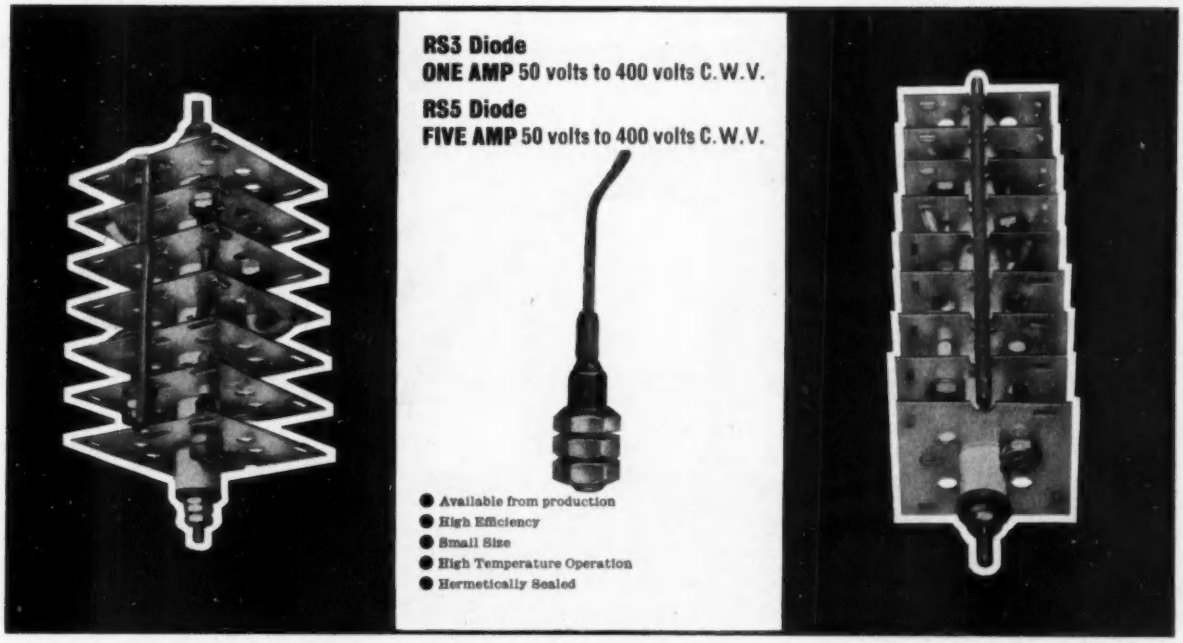
You should have details on file. May we supply literature ?

Hassett & Harper Ltd

REGENT PLACE, BIRMINGHAM, 1 · TEL. CENTRAL 6418

LONDON SHOWROOM : 1 GREAT CUMBERLAND PLACE, LONDON, W.1. · TEL. PADDINGTON 4691

SenTerCel RS3 and RS5 silicon power diodes and rectifier stacks


RS3 Diode
ONE AMP 50 volts to 400 volts C.W.V.
RS5 Diode
FIVE AMP 50 volts to 400 volts C.W.V.
● Available from production
● High Efficiency
● Small Size
● High Temperature Operation
● Hermetically Sealed

Rectifier Stacks

The design of SenTerCel Silicon Rectifier Stacks offers many advantages including small size, low weight and higher ambient operating temperatures (up to 100°C). At present, silicon stacks are supplied with half-wave, bridge or push-pull connections for either single-phase or three-phase inputs. The great variety of possible series and parallel connections between diodes provides an extensive range of voltage and current outputs.

Write for STC silicon rectifier technical literature:

STC COMPONENTS GROUP

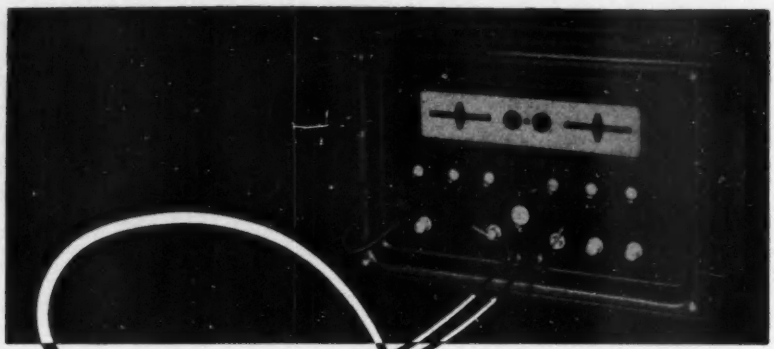
61/12MF

Standard Telephones and Cables Limited

Registered Office : Connaught House, Aldwych, London W.C.2

RECTIFIER DIVISION: EDINBURGH WAY · HARLOW · ESSEX

EE 30 136 *for further details*

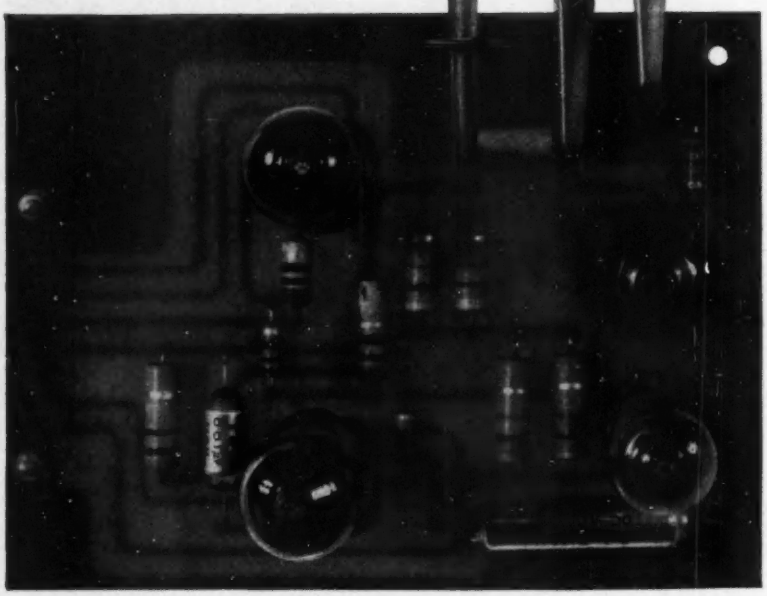


measuring 1pF - at the end of a lead as long as you like

Accurate, remote measurement extends dramatically the application of bridge techniques.

Measurement of the individual components of complex impedances to an accuracy of ±0.25%, without removing them from circuit, coupled with facilities for two, three and four terminal measurement, enable the Universal Bridge B.221 to be put to an almost limitless range of general industrial use.

The instrument will establish the characteristics of components and of circuits—further, special adaptors are available to cover the measurement of liquid conductivity, dielectric constants of solids and liquids, dry joints, switch contact resistance, circuit strays, boundary layer impedance of liquids, permittivity and loss factor of solids and liquids—and dielectric properties of liquids in test tubes.



Foolproof, direct reading dials

The Universal Bridge B.221 has as a special design feature the layout of the controls and displays. A novel mechanism automatically inserts the cyphers, decimals and units of measurement in the dial windows. Thus, the errors which may be caused by large multiplying factors are obviated. This facility means that the instrument may be used efficiently even by unskilled personnel.

This instrument and its applications are fully discussed in Information Service Publication AB221—copies available on request.

THE WAYNE KERR LABORATORIES LIMITED
Sales and Service
44 Coombe Road
New Malden, Surrey
Telephone: MALden 2202

WAYNE KERR

Universal Bridge B221

WK4

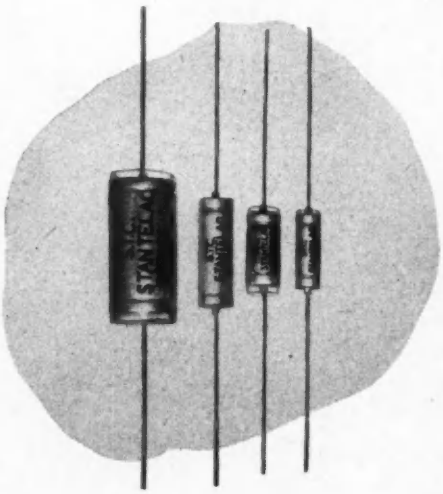
EE 30 137 *for further details*

STC

'STANTELAC'

COATED FOIL CAPACITORS

a new development in Capacitor manufacturing techniques



EXCELLENT ELECTRICAL CHARACTERISTICS

HIGH STABILITY PERFORMANCE

SMALL PHYSICAL SIZE

LOW WORKING VOLTAGES
FOR TRANSISTOR CIRCUITS

TEMPERATURE RANGE —40°C TO +70°C.
H.I. CLIMATIC PROTECTION

CAPACITANCE RANGE 0·01μF TO 2·2μF

Send for details of the Stantelac range of capacitors and life test performance —

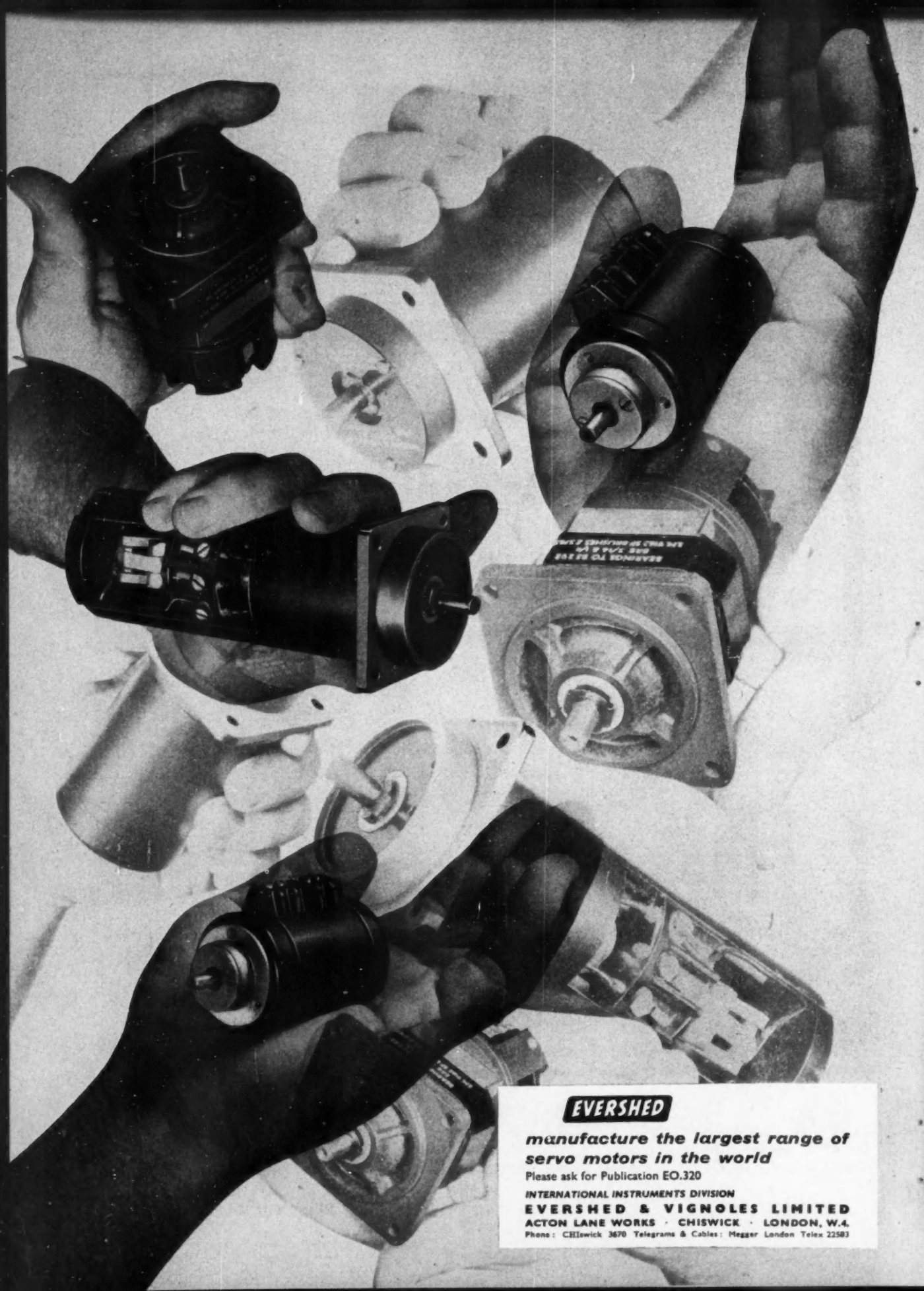
STC COMPONENTS GROUP

61/4MC

Standard Telephones and Cables Limited

Registered Office: Connaught House, Aldwych, London, W.C.2

CAPACITOR DIVISION: BRIXHAM ROAD · PAIGNTON · DEVON



EVERSHED

manufacture the largest range of servo motors in the world

Please ask for Publication EO.320

INTERNATIONAL INSTRUMENTS DIVISION

EVERSHED & VIGNOLES LIMITED

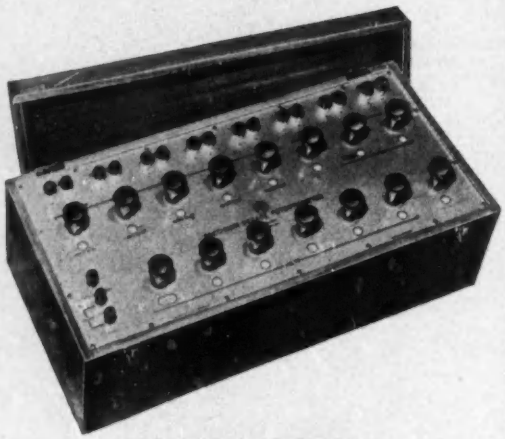
ACTON LANE WORKS · CHISWICK · LONDON, W.4.

Phone: CHIswick 3670 Telegrams & Cables: Megger London Telex 22583

The AMPEX CP-100 is a compact, extended-frequency instrumentation tape recorder/reproducer. Tape transport, motor drive amplifier, heads, power converter, controls and all-transistorized plug-in record/reproduce electronics are contained in a single 13¼" x 19" x 33¼" mobile case. The CP-100 operates on 28-volt DC, with 48 to 400 cycle converters available for other power sources. Data is recorded by direct or FM carrier techniques on up to 14 analogue tracks. The CP-100 offers frequency response to 200 Kc at 60 ips or expanded recording time of 24 minutes for 100 Kc data at 30 ips on a standard 10½" reel. Transport tape speeds – 1⅞, 3¾, 7½, 15, 30 and 60 ips – and plug in frequency determining units and equalizers associated with tape speeds, may be quickly changed. The versatile and mobile CP-100 performs reliably over a temperature range of from −50° F to +160° F, up to an altitude of 10,000 feet, in relative humidities to 95%... and is designed to withstand shocks and vibrations encountered in rugged mobile testing applications. This recorder may also be rack mounted if desired. For complete details write Ampex Great Britain Limited, Arkwright Road, Reading, Berkshire, England. AMPEX

EE 30 140 *for further details*

FOR POTENTIOMETERS

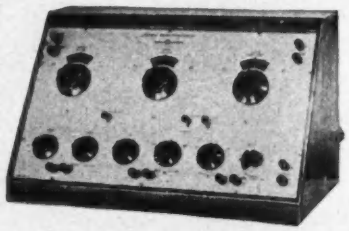


PRECISION DECADE POTENTIOMETER

Cat. No. 7600

The concept of a decade potentiometer has long appealed to instrument-makers but, until the advent of the Pye 6001 Precision Instrument Switch, practical development was not possible. This new Pye Decade Potentiometer offers faultless performance without maintenance and presents information in the most convenient form. Each instrument is submitted to the National Physical Laboratory for certification and yet its unprecedented ease of operation enables it to be used by comparatively unskilled personnel.
Decade switching is used throughout and slidewires are completely eliminated. Direct in-line reading of volts is given in decimal presentation on all ranges. A calibrated five decade current control gives variations down to 1 part in 1,000,000. Several ingenious switching facilities enable all measurements, checks and system reversals to be made without any interference to circuit connections.

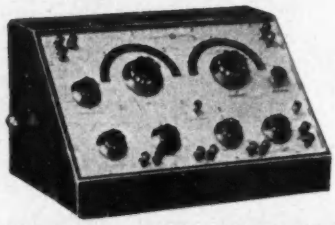
Total range: 1.99999V to -0.1 microvolt
Accuracy of potential division: ± 0.001%
Accuracy of standardizing circuit: ± 0.001%
A fully descriptive leaflet is available.



Cat. No. 7568

PRECISION VERNIER POTENTIOMETER

For numerous precise applications in research. Readings from three switched dials. Range -10 μV to 1.901V. Divisions down to 1 μV. Accuracy ± 0.002%. Alternative horizontal presentation if preferred.



Cat. No. 7565

UNIVERSAL PRECISION POTENTIOMETER

Featuring a continuously variable rhodium-plated Manganin slidewire, protected against wear by an ingenious device. Range -500 μV to 1.75V. Divisions down to 1 μV. Accuracy ± 0.02%.

Cat. No. 7569/P

PORTABLE POTENTIOMETER

A self-contained instrument complete with accumulator, robust galvanometer and standard cell. Range 0 to 1.8V. Divisions down to 10 μV. Accuracy ± 0.1%.

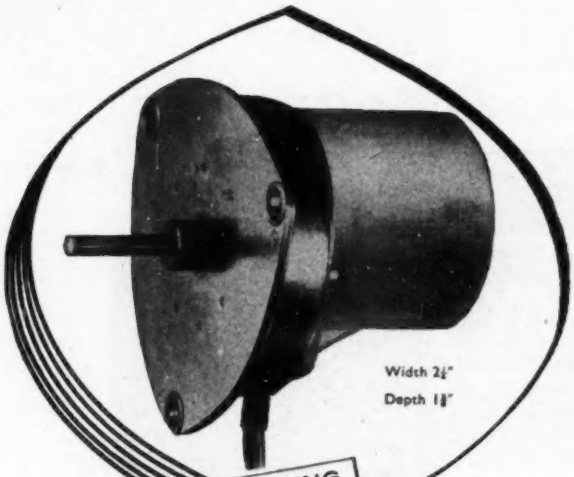
THERMOCOUPLE TEST SET

With every facility for testing thermocouples and their associated indicators, controllers, recorders and alarm relays. A potentiometer, potential source and Wheatstone bridge combined in one compact unit.

Cat. No. 7556

SCIENTIFIC PYE INSTRUMENTS

W. G. PYE & CO. LTD.
GRANTA WORKS, P.O. BOX 60, CAMBRIDGE, ENGLAND
Tel: Cambridge 58866 (5 lines). Grams: Pye Cambridge



SEQUENCE SWITCHING

CHART RECORDERS

SMITHS

CONSTANT SPEED MOTORS

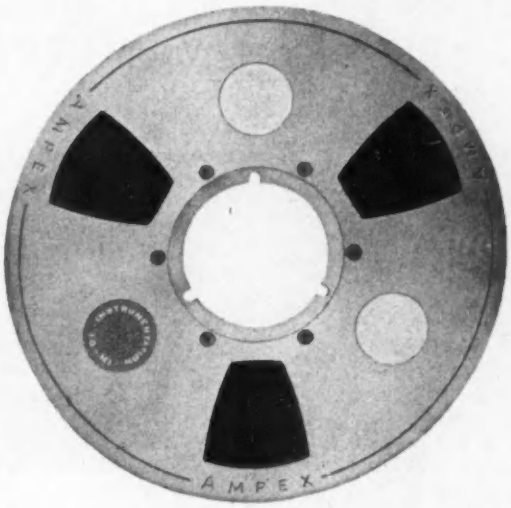
PROCESS CONTROLLERS

SLOT METERS

AUTO-LUBRICATION

Write or telephone now for full details of this versatile compact, multi-purpose LIGHT DUTY Motor Unit with the sintered bronze rotor bearings that ensure years of reliable service. SELF-STARTING. POWER CONSUMED 2 WATTS. WIDE VARIETY OF OUTPUT SPEEDS.

SMITHS CLOCK & WATCH DIVISION
Contracts Branch, 179 Great Portland Street, W.1. *Telephone: LANgham 5811*
Overseas enquiries to Sectric House, N.W.2. England. *Telephone: GLAdstone 6464*



AMPEX Instrumentation Tapes are premium quality magnetic tapes designed for analogue recording by any of the basic techniques. Magnetic properties include high sensitivity, and a wide dynamic range with a stable output throughout the life of the tapes. Exceptionally smooth, hard surfaces provide cleaner operation with less oxide shed, offering greater reliability and reduced maintenance. These tapes are available in configurations for a wide variety of applications. They are offered on acetate or Mylar* backing films, in thicknesses of 0.6, 1.0 and 1.5 mils, and in various widths and lengths. All are supplied on high-performance Ampex Precision Reels or on NAB-type reels. For application information write to Ampex Great Britain Limited, Arkwright Road, Reading, Berkshire, England. AMPEX

*DUPONT TM

EE 30 143 *for further details*

supreme in performance · stability · consistency

Years of research, still continuing, are behind the brilliant, versatile range of Magloy magnets offered by Preformations Limited. Exceptional characteristics are due to the use of special precipitation hardened alloys treated by the most advanced methods known in magnet technology. The extensive manufacturing resources of Europe's most up-to-date magnet foundry assure positive advantages for all users. Applications are legion—Magloy magnets satisfy the most stringent requirements in electronics, engineering and domestic equipment.

Preformations Limited offers a unique design engineering service and will undertake the research necessary for the development of special magnets to meet specific requirements. Write for the Magloy brochure—on company headed notepaper please.

MAGLOY CAST PERMANENT MAGNETS

Preformations Limited

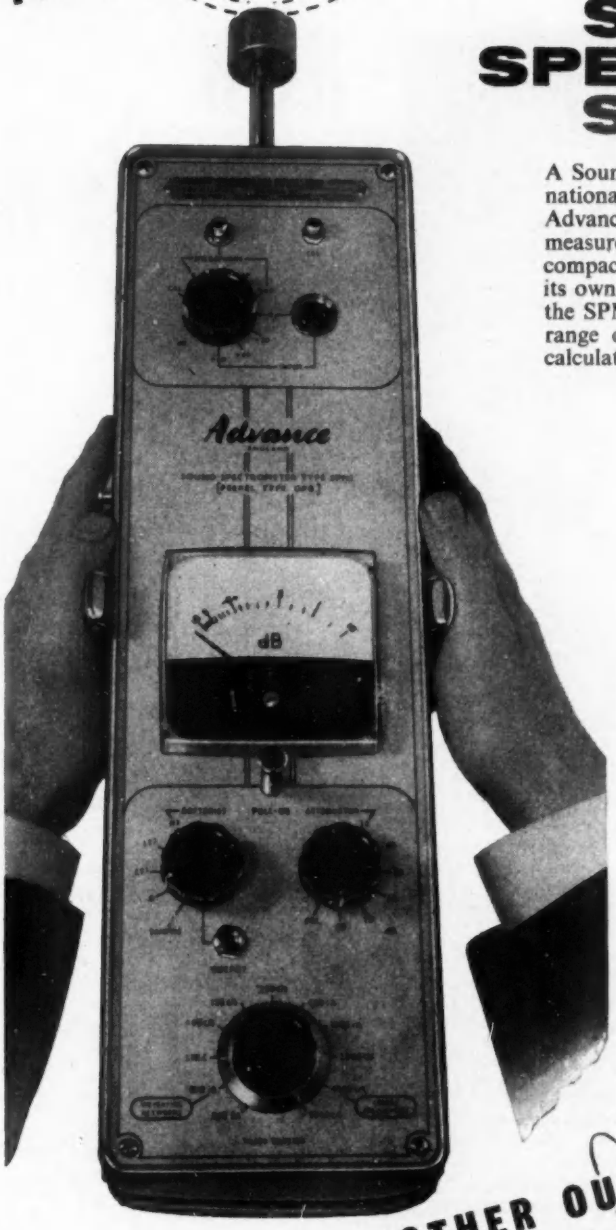
ONE OF THE Plessey GROUP OF COMPANIES

CHENEY MANOR · SWINDON · WILTS
Telephone SWINDON 6251 · Telex 44-385

P.M.1

FROM THE SOUND OF THINGS....

SOUND SPECTROMETER SPM 1



A Sound Spectrometer conforming fully with the international requirements of the Rapallo Convention, the Advance SPM1 provides for the accurate and rapid measurement and analysis of noise from any source. A compact and light-weight instrument, self-contained with its own battery power supply and sensitive microphone, the SPM1 is truly portable and well adapted to a wide range of applications involving the measurement and calculation of:

- ★ SOUND LEVEL AND NUISANCE VALUE
- ★ ACOUSTIC INSULATION
- ★ BACKGROUND NOISE AND SPEECH VALUE
- ★ ACOUSTIC AND VIBRATION INVESTIGATIONS AND ANALYSES

SPECIAL FEATURES INCLUDE

- Built-in meter for monitoring sound pressures from + 20dB to + 150dB and 'loudness' at three 'weightings'.
- Jack for connection of headphone for aural monitoring.
- Choice of eight filters covering the range 20 c/s to 12000 c/s.
- Built-in retractable microphone.
- Provision for connection of external microphone, or for connection of transducer or accelerometer for vibration measurements.

THE ESSENTIAL INSTRUMENT FOR ALL ACCOUSTIC INVESTIGATIONS

NET PRICE in U.K. **£210**

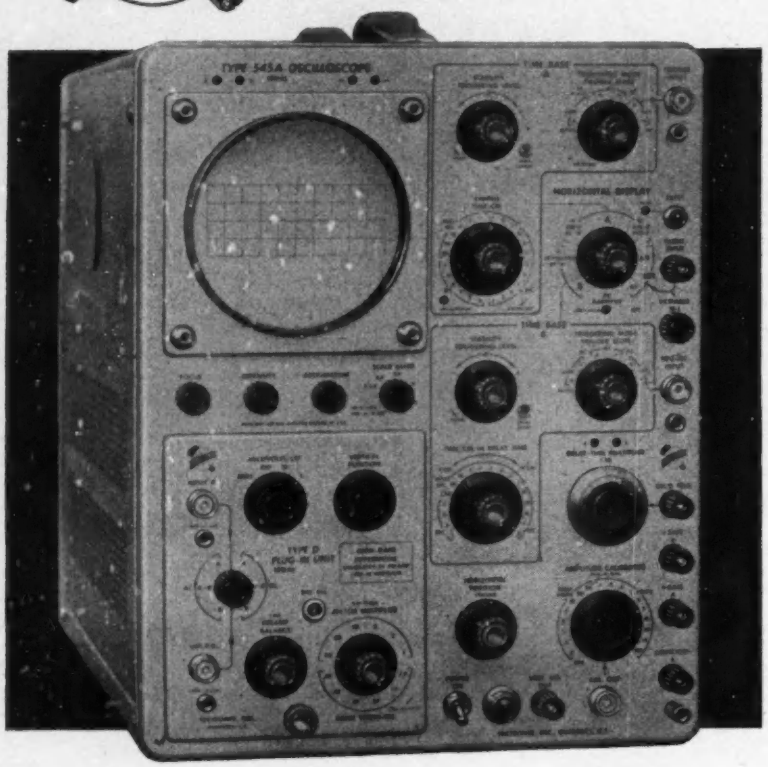
.....ANOTHER OUTSTANDING INSTRUMENT from Advance

Advance COMPONENTS LIMITED
INSTRUMENTS DIVISION
ROEBUCK ROAD • HAINAULT • ILFORD • ESSEX • TELEPHONE : HAINAULT 4444

IT/F/a

EE 30 145 *for further details*

TEKTRONIX OSCILLOSCOPES



NOW BRITISH MADE in GUERNSEY (C.I.)

Deliveries from Guernsey production have been made for two years—now the first types to qualify for Duty Relief under Commonwealth Preference are:—

545A—Vertical amplifier bandwidth DC to 30M/cs.
Two time base generators:
Time Base A— Calibrated steps 0.1μS/cm to 5 S/cm. Continuously variable 0·1μS/cm to 12 S/cm; also X5 magnifier.
Time Base B— Calibrated steps 2μS/cm to 1 S/cm (to 0·4μS/cm with magnifier).
Versatile Triggering — Jitter introduced by delay and pick off circuitry less than one part in 20,000.
Calibrated delay 1μS to 10 S. Incremental accuracy 0·2%.
£609 *(Delivered U.K.)*
together with a wide range of Plug-in Units from £53 *(Delivered U.K.)*

515A—Frequency response D.C. to 15 Mc/s.
Vertical sensitivity continuously variable from 50mV/cm to 50V/cm. Calibrated sweeps from 0·2μS/cm to 2 S/cm (0·04μS/cm with X5 Magnifier). Uncalibrated sweeps continuously variable from 0·04μS/cm to 6 S/cm. Versatile triggering.
Two signal inputs with 60 dB separation. **£315** *(Delivered U.K.)*

The world's finest
PRECISION OSCILLOSCOPES
are now available to
BRITISH USERS
DUTY FREE

Other types of Tektronix Oscilloscopes are being made in Guernsey and additions to the Duty-free list will be announced over the next few months.
Write now for full technical information to the sole Tektronix representatives in Great Britain:—

LIVINGSTON LABORATORIES LTD.
RETCAR STREET · LONDON · N.19
Telephone: ARCHWAY 6251

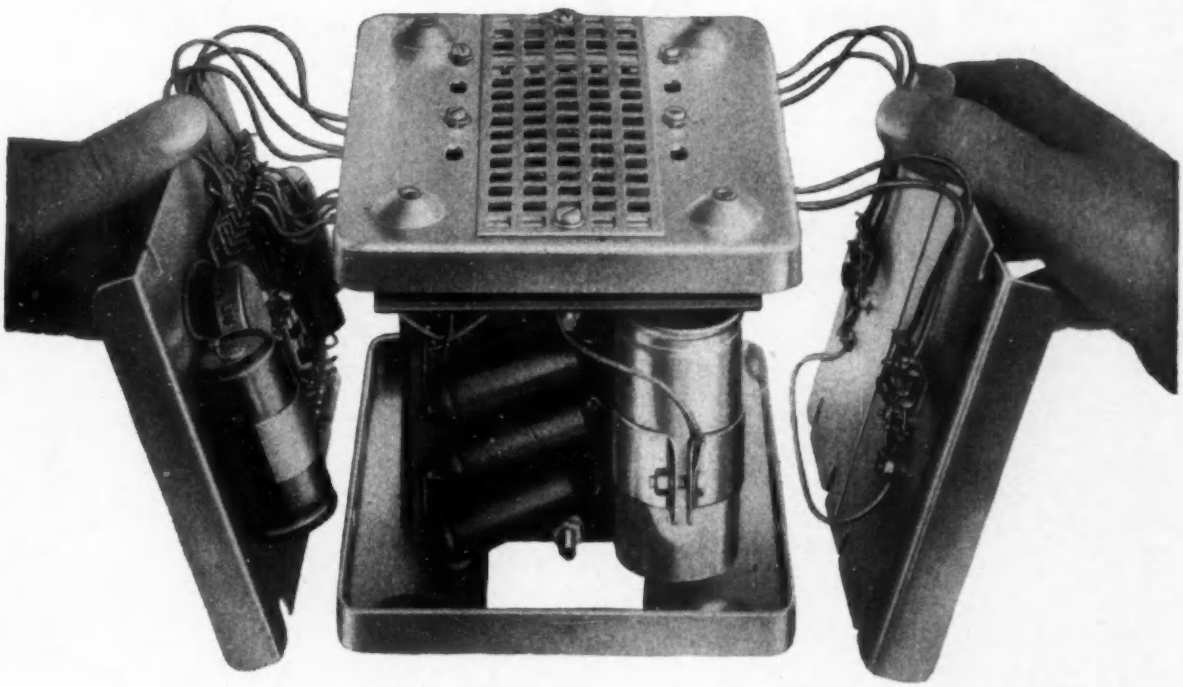
EE 30 146 *for further details*

Low in cost - Highly flexible

TRANSISTOR P.S.U.s

Here is the most economical and convenient method of obtaining low voltage power supplies to meet differing production or laboratory requirements.

Mullard Equipment Limited has produced a range of P.S.U. sub-assemblies, consisting basically of four simple units which, readily added one to another in building brick fashion, will provide power from 1 to 39 volts. And they will do this most economically. A 1 amp stabilised supply need cost only £25.



The four basic units are:—

- ✳ **1 amp Unstabilised Unit (YL. 6101)**
- ✳ **5 amp Unstabilised Unit (YL. 6102)**
- ✳ **250 mA Stabiliser and Reference Section (YL. 6103)**
- ✳ **Series Regulator Section (YL. 6104)**

Constructed for easy assembly, the basic units may be duplicated in operation for higher power applications.

These P.S.U.s are ideally suited for use in equipments and systems employing other Mullard Equipment sub-assemblies such as the well-known Norbits and Combi-Elements.

For further details please write to:

MULLARD EQUIPMENT LIMITED

Mullard House • Torrington Place • London WC1 • Tel: Langham 6633

MS 671

EE 30 147 *for further deatils*

NEW!

miniature wafer rotary switch

SMALLER THAN a half-penny

This entirely new switch, developed by NSF—OAK, brings far greater flexibility and reliability to "miniature" circuits. Available in single or multi-bank with provision for 18 contacts per wafer. Printed circuit or conventional soldering tags according to application.

Write for Engineering Bulletin No. 9.

Licensees of Oak Manufacturing Co., Chicago, U.S.A.

NSF

'The Switch People'

NSF LIMITED · KEIGHLEY · YORKS

A Member of the Simms Group of Companies

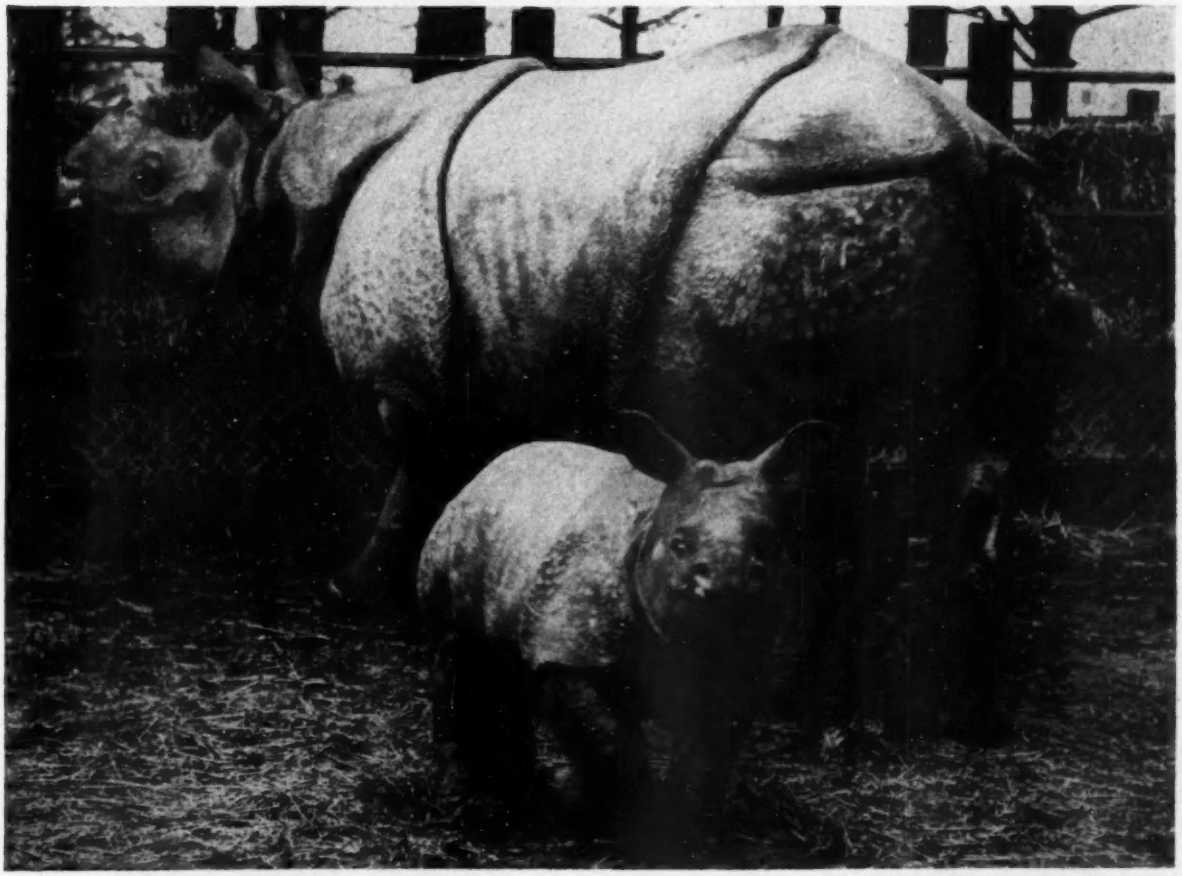
SALES OFFICE: 31/32 ALFRED PLACE, LONDON, W.C.1 *Telephone: LANgham 9561*

EE 30 148 *for further details*

G.E.C. Variable Capacitance Diodes now available

The SVC11-17 series of silicon variable capacitance diodes is designed for use in parametric amplifiers at frequencies up to S-band. These devices are the first of their kind to be produced in this country. The diodes are suitable for use in radar and other communications systems and are designed for high power dissipation so that no elaborate precautions against surges are necessary.
The device can be used as a frequency multiplier—an important step towards the realisation of a microwave receiver based entirely on solid state devices—and because of its very low forward impedance and very high reverse impedance it can also be used as a microwave switch. The diode is mounted in a coaxial structure for direct insertion into coaxial and waveguide circuits and it has the low series inductance of 0.5 mμH. The range consists of diodes of minimum cut-off frequencies from 25 to 85 kMc/s in 10 kMc/s steps. Reverse polarity versions of SVC11 and 12 are SVC21 and 22 for use in balanced circuits.
For full information on this series please write to the address below

Produced in Britain for the first time

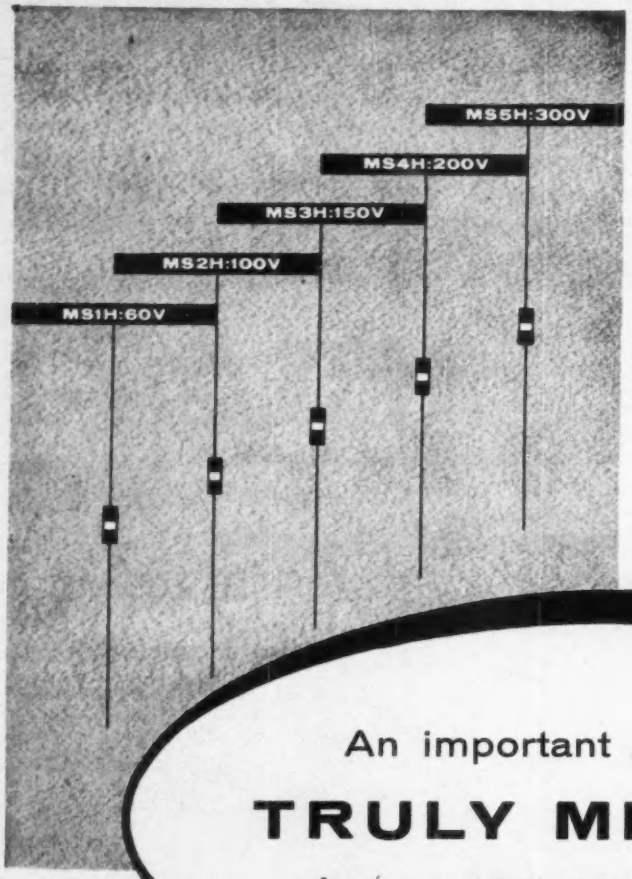


The first baby 'Rhino' born in Britain (1957)

G.E.C. **SEMICONDUCTORS**

The General Electric Co. Ltd., Semiconductor Division,
School Street, Hazel Grove, Stockport, Cheshire.
(London Sales Office: TEMple Bar 8000, Ext. 10)

EE 30 149 *for further details*



Ideal for Computer, Radar, Aircraft and other applications where miniaturisation is important

FIVE TYPES cover max. working voltages from 60V to 300V. Construction: hermetically sealed glass envelope with wire lead at each end.

An important AEI series of

TRULY MINIATURE

¼-amp SILICON DIODES

SPECIFICATION DETAILS

MINIATURE SIZE	Body only 7/64 in. dia., ¼ in. long, overall length 2½ in.
HIGH RATING	250 mA max. mean forward current
LOW LEAKAGE	1.0μA max. at 25°C at max. P.I.V.
LOW FORWARD VOLT DROP	1.0V max. at 200 mA
JUNCTION CAPACITANCE	5 pF max. at −1.0V
STORED CHARGE	20 m μ C max. (I_F=10 mA, V_R=−10V, R=1000Ω)

Please write for information Sheet EAD. 8012-1 and address enquiries to your nearest AEI Regional or District office, or

AEI

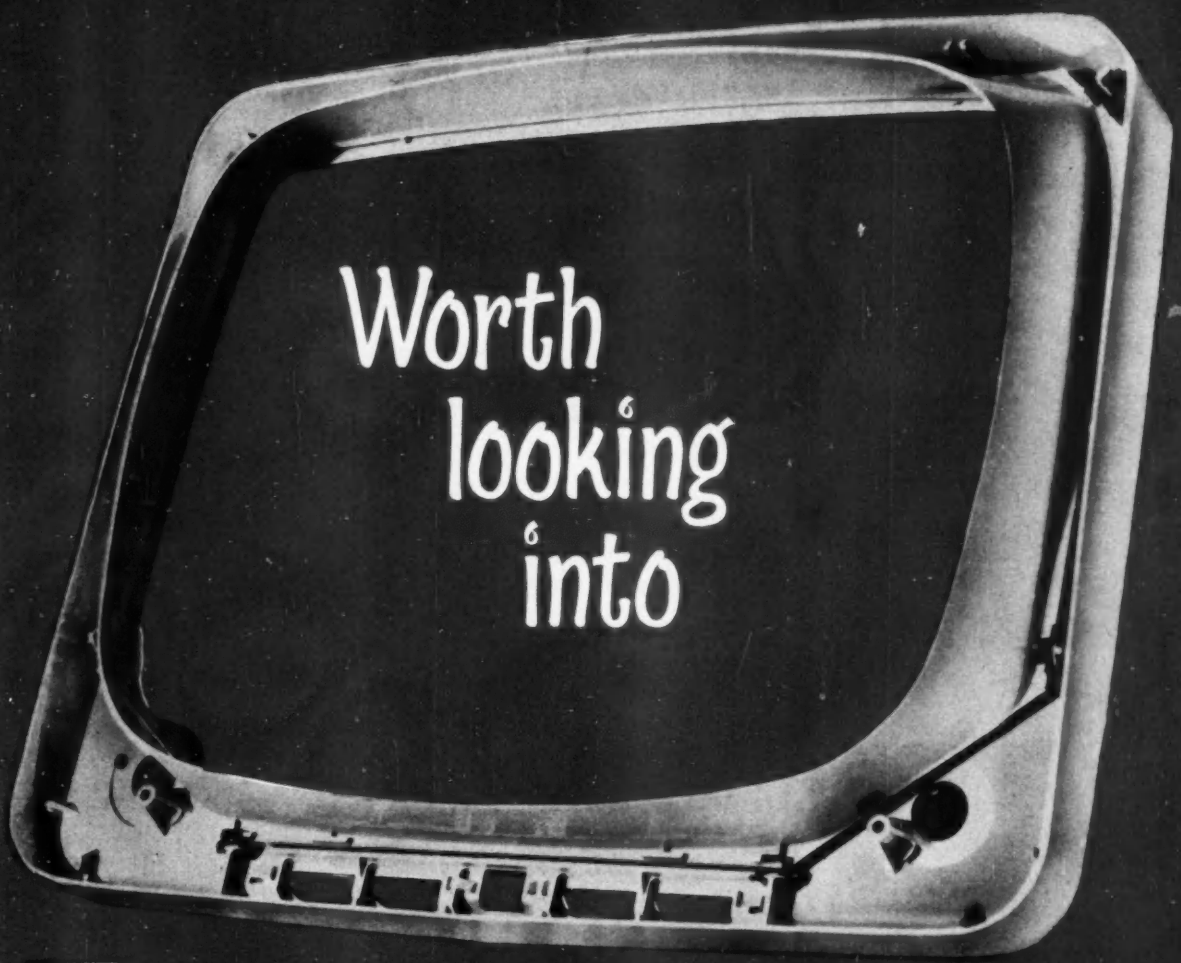
Associated Electrical Industries Limited

Electronic Apparatus Division

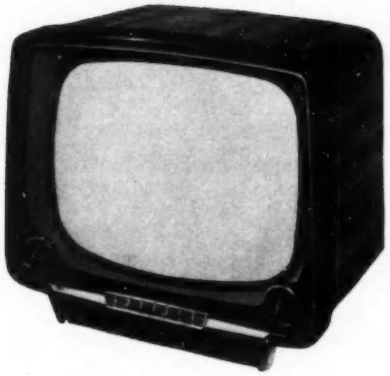
VALVE AND SEMICONDUCTOR SALES

LINCOLN, ENGLAND.

A5595



Bextrene BC 15



Chosen as the ideal material for these intricate mouldings for the RGD Television set.

For surface Finish
which enhances the prestige look of the set.

For Impact Strength and Dimensional Stability
a frame which resists distortion and protects the fragile interior.

For good Mouldability
Because of its toughness, Bextrene mouldings can be ejected without fracture from really intricate dies.

Screen surround and mask for television set moulded in two interlocking sections by Halex for R.G.D. (Radio Gramophone Development Co. Ltd.)

Bextrene BC 15 is available in a wide range of attractive colours

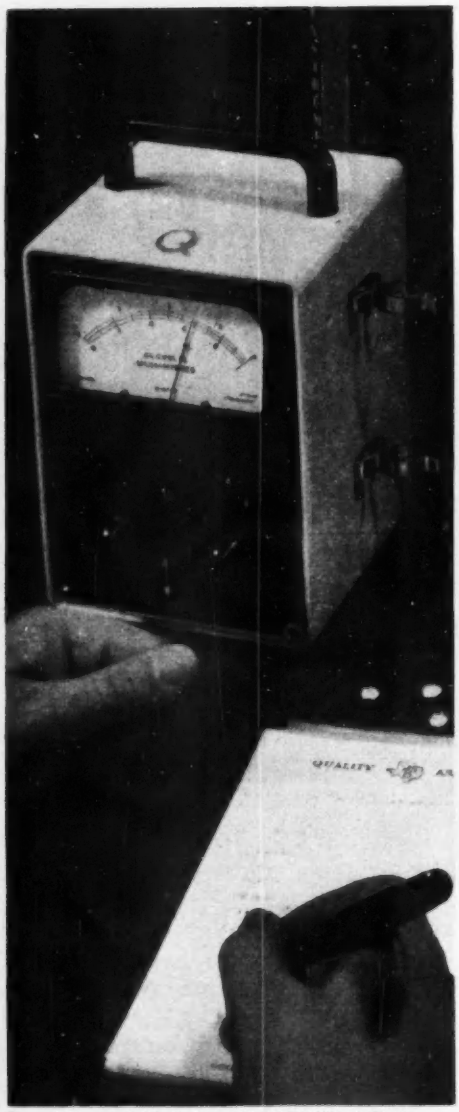
Write for publication No. 582 to

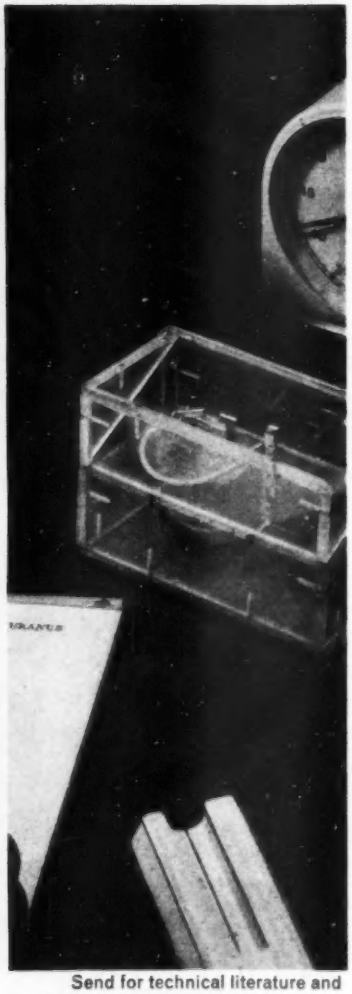
BX PLASTICS LTD., The British Xylonite Group, London E.4 LARkswood 5511

EE 30 151 *for further details*

NASHTON provides accuracy assurance for **TEXAS** quality assurance

NASHTON instruments not only give you accuracy at a reasonable price but are designed for ease and simplicity of use, for rapid mistake-free repetitive readings. The Texas Quality Assurance Department uses no less than five different **NASHTON** models. For there's a wide range – a family – of **NASHTON'S** – measuring instruments, test instruments power supply units – all highly rationalised, all of modular design, all miniaturised, all economically engineered according to the **NASHTON** philosophy.





Texas Instruments Limited use NASHTON Flash Testers, AC/DC Valve Voltmeters, DC Valve Voltmeters/ Microammeters, Sensitive Valve Voltmeters, 1A and 0.5A Power Supplies.
You may also need NASHTON Ohmmeters, RCC Bridges, Shorted Turn Detectors, Universal DC Meters, Transistor Testers and Oscillators, Preferred Value R & C Boxes, LF Quadrature Oscillators.

Would you like to receive a catalogue? If so, please write or telephone now.

Send for technical literature and see the extent of the **NASHTON** range – examine the specifications – and see how **NASHTON** economic engineering brings down the price Let **NASHTON** instruments make their contribution to *your* quality and to *your* economic engineering

Nash and Thompson

Limited

Hook Rise South, Surbiton, Surrey.
Telephone: ELMbridge 5252

LOOK TO TEXAS FOR GERMANIUM TRANSISTORS

2G101 | **2G102**
100 Mc/s amplifier | 200 Mc/s amplifier

V.H.F. 'Mesa'

2G110
V.H.F. Medium Power 'Mesa'
150 mW @ 100 Mc/s

2G301 · 2G302 · 2G303
2G304 · 2G306
R.F. & Computer Alloy Junction
Up to 25V
f_1 (min) 3, 7 & 12 Mc/s

2N711
High Speed Computer Switch
10 Mc/s saturating switch
2G103 · 2G104
Special purpose versions of 2N711

2G240
High Frequency Power
I_C = 3A V_{CB} = 80V
f_1 = 15 Mc/s (min)

2N456 · 2N457 · 2N458
Power (5A)
Up to 80V
β 30-90 @ 5A

. . . and of course the widest range of SILICON DEVICES in the industry

Data Sheets and Application Information are available on all TEXAS semiconductor devices, which include:

PNP Germanium Transistors Computer · U.H.F · Power
Silicon Zener Voltage Regulators
Silicon Rectifiers & Diodes
High Voltage · Signal · Computer · Photo · Zener

PNP & NPN Silicon Transistors
Switching · Signal · U.H.F · Power
Silicon Controlled Rectifiers
Tantalum Capacitors

TEXAS INSTRUMENTS
LIMITED
MANTON LANE · BEDFORD · ENGLAND
BEDFORD 67466 · CABLES: TEXINLIM, BEDFORD

19/A39

START in DONOVAN Style

A.C. DIRECT-ON-LINE CONTACTOR STARTER

UP TO 5 H.P. 400/500V. 3 PHASE

TYPE A30. SIZE "0"

This exceptionally versatile Starter is not only suitable for 1, 2, or 3 phase, but is made with the lid having:—

START AND STOP PUSHBUTTON (STYLE 1)

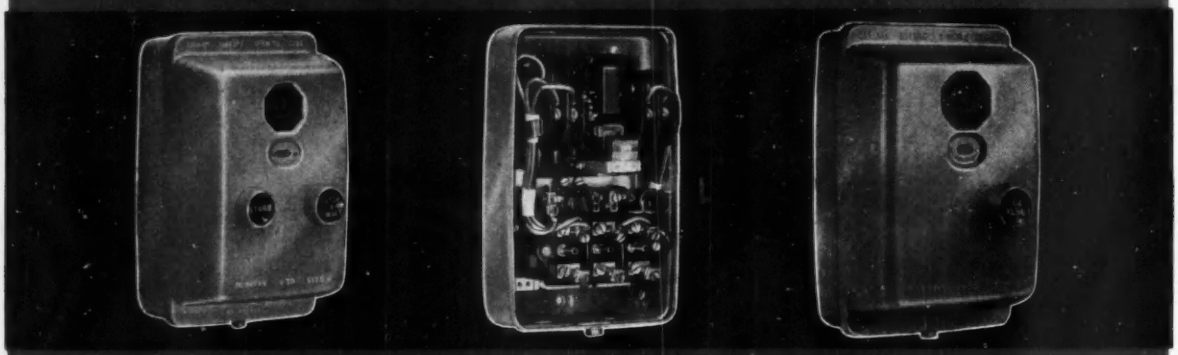
or OVERLOAD RESET BUTTON ONLY (STYLE 2)

or AUTO-ON-HAND SELECTOR SWITCH (STYLE 3)

Two types of enclosure are available:—

GENERAL PURPOSE, in pressed steel;

HOSEPROOF, in cast alloy.



Among the features which contribute to the excellent performance and merit of this starter are:—

- Double-break silver contacts, and patented arc chamber . . . for switching capacity.
- Patented high efficiency magnet . . . for small size and reliability.
- Vertical lift contactor which cannot be jarred closed . . . for safety.
- Complete interior removable by simply slackening 3 screws . . . for speed and convenience.
- Accurate thermal (Solder-film) overloads of patented improved type . . . for reliability.
- Casual alteration of overload setting impossible . . . for motor protection.
- Any H.P. rating within its range, readily altered by fixing the appropriate overload heater coils . . . for small stocks.
- Designed and tested for compliance with B.S.587 (1957) "Severe Mechanical Duty" class and for "Frequent" operation; and with B.S.775 (1956) (Contactor) . . . for confidence.
- Also made as Type A32, with an interlocked stalled motor load-breaking isolating switch . . . for greater safety, ease of maintenance, and in many cases, greater economy.
- Readily available, at attractive prices . . . for your commercial satisfaction.
- Convinced as that a trial order for even one starter is welcomed . . . for assisting you to a new and finer experience of British quality.
- For a modern, reliable, safe, long life starter . . . choose the DONOVAN STYLE today!

VISIT THE DONOVAN STAND AT THE A.S.E.E. EXHIBITION

STAND F 3

GROUND FLOOR

THE DONOVAN ELECTRICAL CO. LTD.

78-82 GRANVILLE STREET, BIRMINGHAM 1

London Depot: 149-151 York Way, N.7. Glasgow Depot: 22 Pitt Street, C.2

Sales Engineers available in LONDON, BIRMINGHAM, MANCHESTER, GLASGOW, BELFAST, BOURNEMOUTH

SILICON TRANSISTORS

for Industry

Now, for the first time, general purpose transistors specifically intended and priced for industrial applications

ACTUAL SIZE

in the JEDEC TO-5 case
for ease of circuit assembly and soldering

β 15-50 ..... 2S701
β 30-90 ..... 2S702

AND NOW HIGH GAIN TYPE β 60-250 .... 2S703

AND THE NEW MEDIUM POWER & HIGH POWER TYPES
2S711 · 2S712

Exceptionally low I_{CEO} (I_{CO}'), lower than I_{CBO} for comparable germanium devices.

No derating from −40°C to +50°C —suitable for equipment designed for Arctic AND Tropical climates.

High cut-off frequency (for 2S701 & 2S702 typically 8 Mc/s—for 2S703 16 Mc/s)—one transistor can be specified for all stages of the equipment.

TEXAS INSTRUMENTS
LIMITED
MANTON LANE · BEDFORD · ENGLAND
BEDFORD 67466 · CABLES: TEXINLIM, BEDFORD

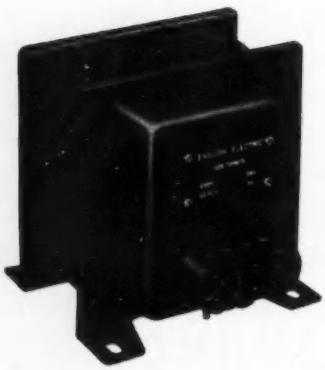
91/A42

EE 30 155 *for further details*

'C' and 'E' cores for smaller... lighter... more efficient transformers

HERMETICALLY SEALED, RESIN CAST, OPEN and COMMERCIAL TYPES

'ENGLISH ELECTRIC' specialise in 'C' and 'E' cores for transformers for industrial, aircraft, commercial and inter-service applications where the need is for increased efficiency in less space and with less weight.



Send enquiries or for Publication TF/239 to:
The ENGLISH ELECTRIC Co., Ltd., Transformer Sales and Contracts Section, East Lancashire Road, Liverpool, 10. Telephone: Aintree 3641

'ENGLISH ELECTRIC'

'C' and 'E' cores

THE ENGLISH ELECTRIC COMPANY LIMITED, ENGLISH ELECTRIC HOUSE, STRAND, LONDON, W.C.2

WORKS: STAFFORD · PRESTON · RUGBY · BRADFORD · LIVERPOOL · ACCRINGTON

TFL.46

Texas MOLY/G* devices

AID AUTOMATIC ASSEMBLY OF ELECTRONIC EQUIPMENT

AVAILABLE NOW IN PRODUCTION QUANTITIES

1S111 Series
High Power Silicon Rectifiers
400mA · 600V

1S914 Series
Diffused Silicon Mesa Computer Diodes
4mμsec · 75mA · 75V

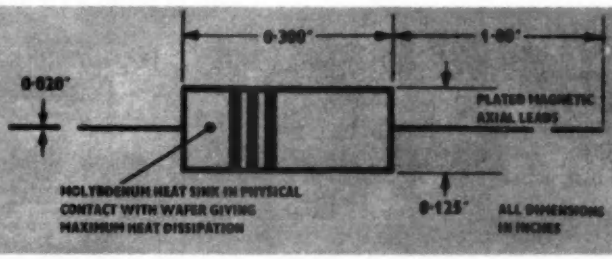
- *Suitable for automatic assembly on printed circuits because of standard size and shape, and magnetic leads.*
- *Special Texas* MOLY/G* *molybdenum-to-hard-glass seal gives resistance to severe mechanical shock.*
- *Long leakage path makes the devices particularly suitable for equipment used in industrial conditions and at high altitudes.*

1S120 Series
Silicon Signal Diodes
200mA · 150V

1S7000 Series
Silicon Voltage Reference Diodes
3·3V-15V · 400mV

- *Low junction temperatures are maintained by molybdenum heat sinks which give high heat dissipation and therefore high thermal capacity.*
- *Matched coefficients of thermal expansion of molybdenum and hard glass envelope eliminate differential heat strain.*
- *The only range of devices of their kind in mass producton in this country—now.*

HALF THE SIZE OF A ¼W RESISTOR



Data Sheets and Application Information are available on all TEXAS semiconductor devices, which include:

PNP Germanium Transistors Computer · U.H.F · Power
Silicon Zener Voltage Regulators
Silicon Rectifiers & Diodes
High Voltage · Signal · Computer · Photo · Zener

PNP & NPN Silicon Transistors
Switching · Signal · U.H.F · Power
Silicon Controlled Rectifiers
Tantalum Capacitors

TEXAS INSTRUMENTS
LIMITED
MANTON LANE · BEDFORD · ENGLAND
BEDFORD 67466 · CABLES: TEXINLIM, BEDFORD

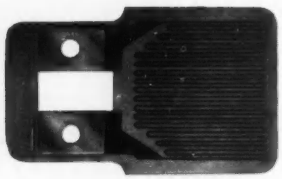
*Trademark

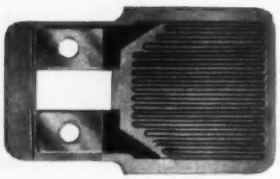
91/A34

FOR PRINTED CIRCUITS AND COMPONENTS

FLEXIBLE PRINTED RESISTORS

- Maximum heat dissipation in restricted space, such as contact cooled mains droppers
- Weight saving—overall thickness can be as little as .001″
- Extremely reliable
- Designed to customers' requirements





These 50 OHM printed resistors (approx. ½ in. sq.) were developed for Joseph Lucas Ltd and are in volume production. A Mills & Rockleys patent

TGA PS2

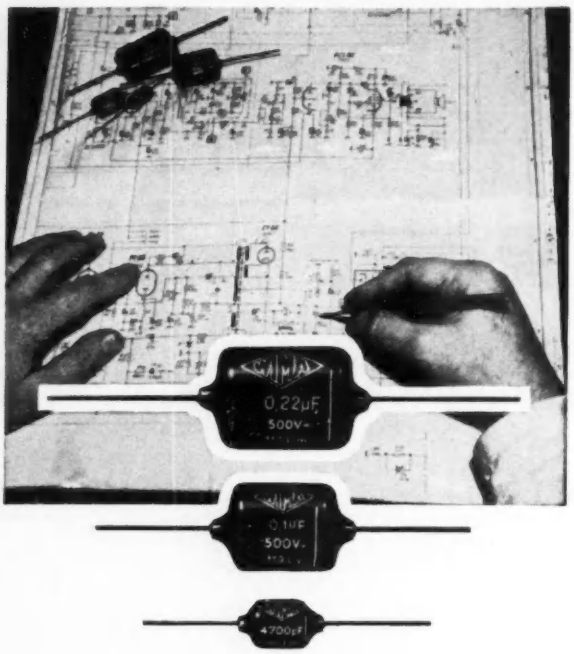
MR

TECHNICAL DESIGN SERVICE

gets *your* circuit ideas into print

For better and faster results contact:

MILLS & ROCKLEYS ELECTRONICS LIMITED
Swan Lane, Coventry. Phone Coventry 26222-3



WIMA

TROPYDUR CAPACITORS

for

Reliability and Long Life

Size and Shape: Because of the unique flat oval design combined with small physical size, WIMA are ideal for printed circuits and where space is valuable.

TECHNICAL SPECIFICATION

Capacity Range: 1000pF to 1mfd in accordance with international E.6. series.

emperature ange: —20°C to +90°C.

Power Factor: Less than 1% at 1500 c/s at 20°C.

Insulation Resistance: Better than 20,000 MΩ at 20°C.

Special Properties: Safe HF contact Low induction. Screened by extended outer foil.

Tolerances:

RANGE	STANDARD	SPECIAL
1000 pF to 0.068 mfd	±20%	±10%
0.1 mfd to 1 mfd	±10%	±5%

CLOSER TOLERANCES

can be supplied for some values against special orders.

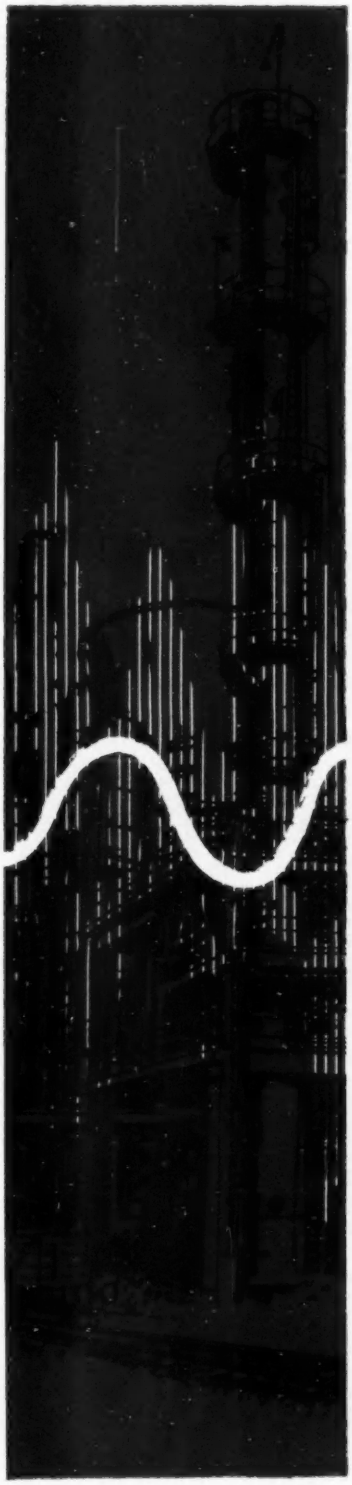
FULL TECHNICAL SPECIFICATION AND PRICES FROM:—

WAYCOM LIMITED

SOLE U.K. AGENTS

EMPIRE BUILDINGS, DUKE STREET HILL, LONDON, S.E.1.
Tel: HOP 2538/9

EE 30 159 *for further details*



DATA*flex*

a new advanced system of integrated instrumentation for data handling and industrial process control

DATAFLEX consists of a wide and increasing range of individual modular units capable of handling even the smallest electrical signals derived from transducers measuring physical quantities. Even when subjected to abnormal background interference, these signals can be amplified to workable size, compared with references, shaped and directed to provide a variety of control functions. Where required output can be displayed, printed out on paper or cards, punched tape or magnetic tape.

Single, double, treble or quadruple modules are designed to plug into a common shelf which houses the equivalent of eight single width modules. With suitable side members, the units can be housed as a complete equipment on standard 19 inch racks. Alternatively, the modules can be enclosed in a suitable instrument case, varieties of which are available to form multi-layered equipments.

The answer to the simplest or most complex data handling or process control system could well be DATAFLEX.

Write now for details of this new range of instruments.

Enquiries should be addressed to:—

INSTRUMENT DIVISION
HIGH CHURCH STREET · NEW BASFORD · NOTTINGHAM

ERICSSON

ERICSSON TELEPHONES LIMITED · HEAD OFFICE · 22 LINCOLN'S INN FIELDS LONDON W.C.2
ER. 13

EE 30 160 *for further details*

A new Grommet development

THE DOUBLE SEALING EMPIRE RUBBER GROMMET

infinitely accommodating in use:
considerably reduces range of sizes
because the same grommet can be used with
several plate thicknesses or cable sizes

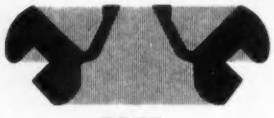
PAT. APP. No. 5255/59

This newly developed self-conforming grommet, because it is immediately self-locking against the elements, is the solution to many of an engineer's sealing problems.
Any one size will not only accommodate itself to a variety of mounting plate thicknesses, but (designed for cable or control rod) will take these in a variety of sizes and be weather-, water- and dust-proof at a variety of angles to the cable or rod.

Because of its capacity to conform to many varying requirements, it enables a workshop stock range of grommets to be reduced to perhaps one tenth of that at present maintained.

THE NEW BLIND GROMMET

FREE



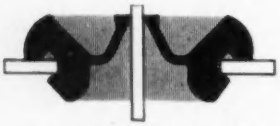
FREE

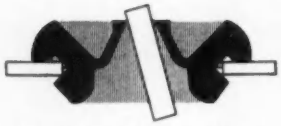
THE NEW DESIGNED GROMMET

FITTED

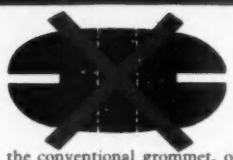
Note how when sprung into position the grommet provides a perfect double seal by its own permanent pressures. The angled groove also creates a tight pressure hold on the metal plate.

In the cable grommet variety the same double pressure seal is created. allied to tight seal on various diameters of cable. This new grommet gives sound sealing at *all* vital points.





A useful feature of this cable grommet is that by reason of the designed taper of the cable entry and the flexibility of the web, a considerable angle of cable entry and a variety of cable size are possible. This avoids necessity for special grommets with angled bores.



In the conventional grommet, only one thickness of plate and only one size of cable can be accommodated. No effective seal is afforded by the parallel groove.

Now being produced in a range of sizes.

THESE GROMMETS WILL SOLVE YOUR SEALING PROBLEMS.

ENQUIRE
for Catalogue section and detailed particulars.

EMPIRE RUBBER COMPANY · DUNSTABLE · BEDFORDSHIRE · ENGLAND

R.B.101

SILICON POWER TRANSISTORS

Ref: SP	2N1479 2N1481	2N1480 2N1482	2N1483 2N1485	2N1484 2N1486	2N1487 2N1489	2N1488 2N1490	UNITS (max)
Collector-base voltage	60	100	60	100	60	100	volts
Collector-emitter voltage with base open	40	55	40	55	40	55	volts
Emitter-base voltage	12	12	12	12	10	10	volts
Collector current	1.5	1.5	3	3	6	6	amps
Transistor dissipation At case temp. 25°C	4	4	15	15	60	60	watts
At case temp. 100°C	2	2	7.5	7.5	30	30	watts

Write for Data Sheets quoting reference to:

ASSOCIATED TRANSISTORS LIMITED

SHAFTESBURY HOUSE · SHAFTESBURY AVENUE · SOUTH HARROW · MIDDX · BYRON 9571

A.T.4

SILICON MESA TRANSISTORS

Ref: SM	2N1491	2N1492	2N1493	UNITS
Collector-emitter voltage with emitter-base reverse biased	30	60	100	volts
Emitter-base voltage	1	2	4.5	volts
Collector current	50	50	50	mA
Transistor dissipation Free air $T_A = 25°C$	0.5	0.5	0.5	watts
$T_A = 100°C$	0.25	0.25	0.25	watts
Heat sink $T_C = 100°C$	1.5	1.5	1.5	watts
Alpha cut-off frequency	250	275	300	Mc/s
Typical power gain at 70 mcs	15	15	12	dB

DIRECT PHASE and AMPLITUDE MEASUREMENTS in POLAR (R,θ) and CARTESIAN (a,jb) CO-ORDINATES

- *Signal in Polar (R, ⊖) and Cartesian (a, jb) Coordinates*
- *Frequency range 0.1 c/s — 1 kc/s (± 2% accuracy)*
- *Identification of vector quadrant*
- *High sensitivity (50 mV F.S.D.)*
- *Discrimination against noise and distortion*
- *Optional Log Amplitude/Phase indication for Nichols chart*

SOLARTRON

TRANSFER FUNCTION ANALYSER (T.F.A.)
AND
REFERENCE RESOLVER (JX 746)

The Solartron T.F.A. and Reference Resolver JX 746 combination is unique in that it provides the required response of a system in a form suitable for the direct plotting of Nyquist and Bode diagrams.
The JX 746 extends even further the versatility of the already world famous Solartron T.F.A. and provides a digital display of phase angle.
The basic principles of this new technique in dynamic analysis are best explained by reference to the following experimental procedures.

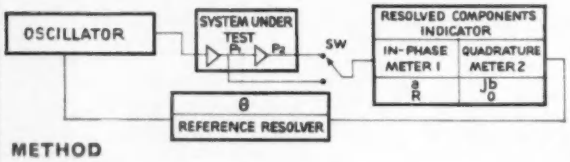
I To plot the Frequency Response of a given system over the range 0.1 c/s — 1 Kc/s in Nyquist and Bode form.

II To plot Amplitude and Phase Difference between two elements within the loop.

APPARATUS

1. Oscillator (OS 103.2)
2. Resolved Components Indicator (VP 253.2)
3. Reference Resolver (JX 746)

LAYOUT



METHOD

I Overall Frequency Response (at P_2)

1st step:

Feed system under test with accurate frequencies over 0.1 c/s to 1 kc/s (Oscillator OS 103.2)

2nd step:

Observe in-phase and quadrature components 'a' and 'jb' shown on Meters 1 and 2 of the Resolved Components Indicator VP 253.2. (see fig. 1)

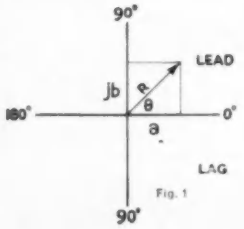


Fig. 1

3rd step:

By means of Reference Resolver (JX 746) rotate reference axes of the Resolved Components Indicator until the quadrature meter reading is zero. (see fig. 2).

4th step:

Note R = reading on Reference Meter 1 and ⊖ = digital reading on JX 746 Plot on Nyquist and Bode diagrams.

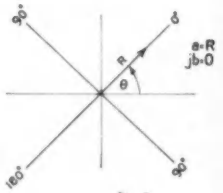
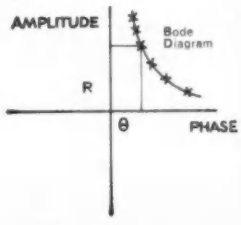


Fig. 2

II Amplitude and Phase Comparison between two points in the system (P_1 and P_2).

Having already resolved P_2 into R and ⊖ form, switch Resolved Components Indicator to P_1 and repeat the 3rd step.
Note differences in Amplitude and Phase on Reference Meter 1 and JX 746 respectively.

RESULTS



The ease of operation and high measuring accuracy of Solartron T.F.A. and JX 746 are unsurpassed in the field of dynamic analysis. These are precision instruments for determining the behaviour of—

Electrical, Mechanical and Hydraulic Servo systems —Amplifiers — Networks — Self Regulating Systems—complete Servomechanisms and Regulators —Automatic Process Control Equipment—etc— under all operating conditions.

The Solartron T.F.A. comprises the L.F. Decade Oscillator (OS 103.2) and the Resolved Components Indicator (VP 253.2)

RESOLVED COMPONENTS INDICATOR VP 253.2

(Frequency coverage 0.5 c/s — 1 kc/s)

This is an L.F. Valve Voltmeter with two special 6" diameter meters indicating in-phase and quadrature components of the signal voltage with respect to a reference voltage of the same frequency.

Spurious noise and harmonics are cancelled out in the unique measuring method employed in this instrument. An amplifier overload indicator ensures that no false readings are taken on the meters, which are themselves protected against overload.

THE REFERENCE RESOLVER JX 746

(Frequency coverage DC — 1 kc/s)

Specially designed for use with the Solartron T.F.A., enables the transfer information to be expressed directly in terms of amplitude and phase. The phase angle is displayed by three digital indicators.

L.F. DECADE OSCILLATOR OS 103.2

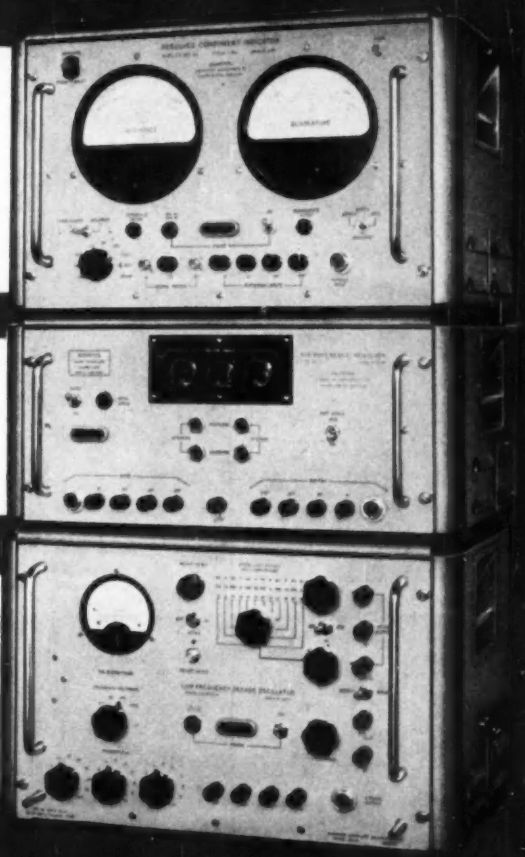
(Frequency range 0.01 c/s — 11.1 kc/s to cover sub-audio and audio)

This oscillator, specially designed for T.F.A., generates low distortion sine-waves 4 phases — 0°, 90°, 180° and 270°.

A built-in meter gives an accurate level indication of the stabilised output down to the lowest frequency.

A precision attenuator enables the 10 V stabilised output to be accurately attenuated in 108 steps down to 10 mV.

A square-wave output is also available, covering the same frequency range and of continuously variable amplitude up to 17 V pk-pk.



For full information write now to:

SOLARTRON LABORATORY INSTRUMENTS LIMITED

Cox Lane, Chessington, Surrey. Tel: LOWer Hook 2150

Cables: SOLARTRON CHESSINGTON

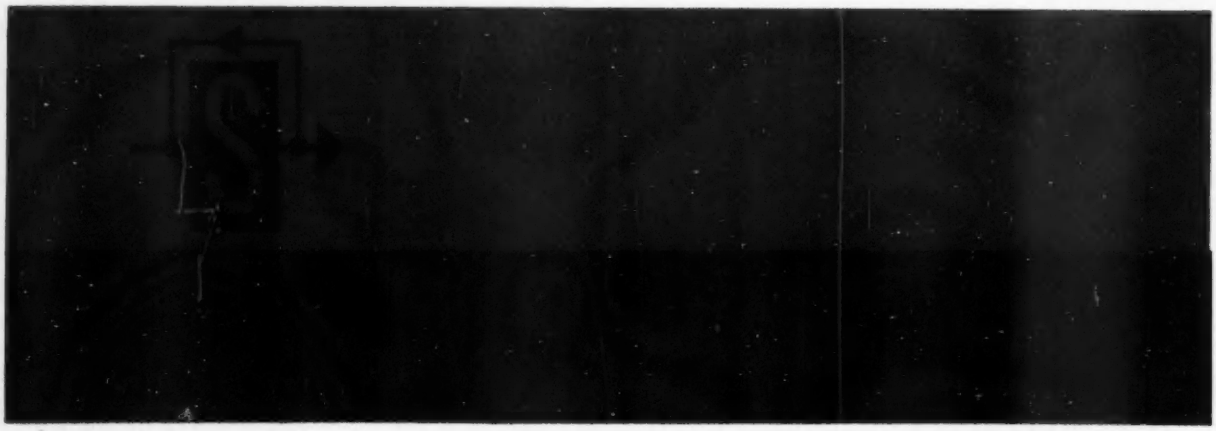
Telex: 23842 SOLARTRON T.DIT.

A member of the Firth Cleveland Group

SOLARTRON

EE 30 164 *for further details*

SERVOMEX
an ever expanding
range of
Instruments and
Controls for
Research, Industry
and Education.



ELECTRONIC ENGINEERING 156 FEBRUARY 1961

EE 30 165 *for further details*

A.C. Voltage Stabilisers

Servomex Controls Ltd., Crowborough, Sussex. Telephone: Crowborough 1060

Superfine Wires by–

B·D·H

Precision resistors and potentiometers must, inevitably, be precise. So must the resistance wires which go into them.

By precise, we don't only mean in the critical matter of size. Superfine wires must match exactly in finish, physical properties and electrical characteristics the requirements of the particular job. These requirements vary widely from one application to the next, and the British Driver-Harris range of superfine wires has been planned to cover them.

Sizes. Starting at .002 in. (0.05 m.m) and working downwards.

Finishes. Bright, oxidised, enamelled, and enamelled and silk covered, for example.

Temper. Annealed or hard.

Nichrome & Nichrome* V.* Nichrome* (65/15 type nickel-chromium-iron) and Nichrome* V (80/20 type nickel-chromium) are the alloys most suitable where a high resistance is necessary and where the change in resistance due to temperature does not hinder satisfactory performance.

Karma.* This is essentially a modified 80/20 nickel-chromium alloy, developed especially for the electronics industry, which combines a high specific resistance with a low temperature coefficient.

Advance.* Wires of this 60/40 copper-nickel alloy have a low temperature coefficient and a fairly high specific resistance —important properties in precision resistors which must have constant resistance over a wide temperature range.

**Reg. Trade Mark*

NICHROME
REGD TRADE MARK

BRITISH DRIVER-HARRIS CO LTD

CHEADLE HEATH,
STOCKPORT, CHESHIRE

For further information write for Data Sheet No. 1, a 4-page booklet containing concise technical information.

EE 30 167 *for further details*

INTERESTED IN CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS IN DEVELOPMENT QUANTITIES?

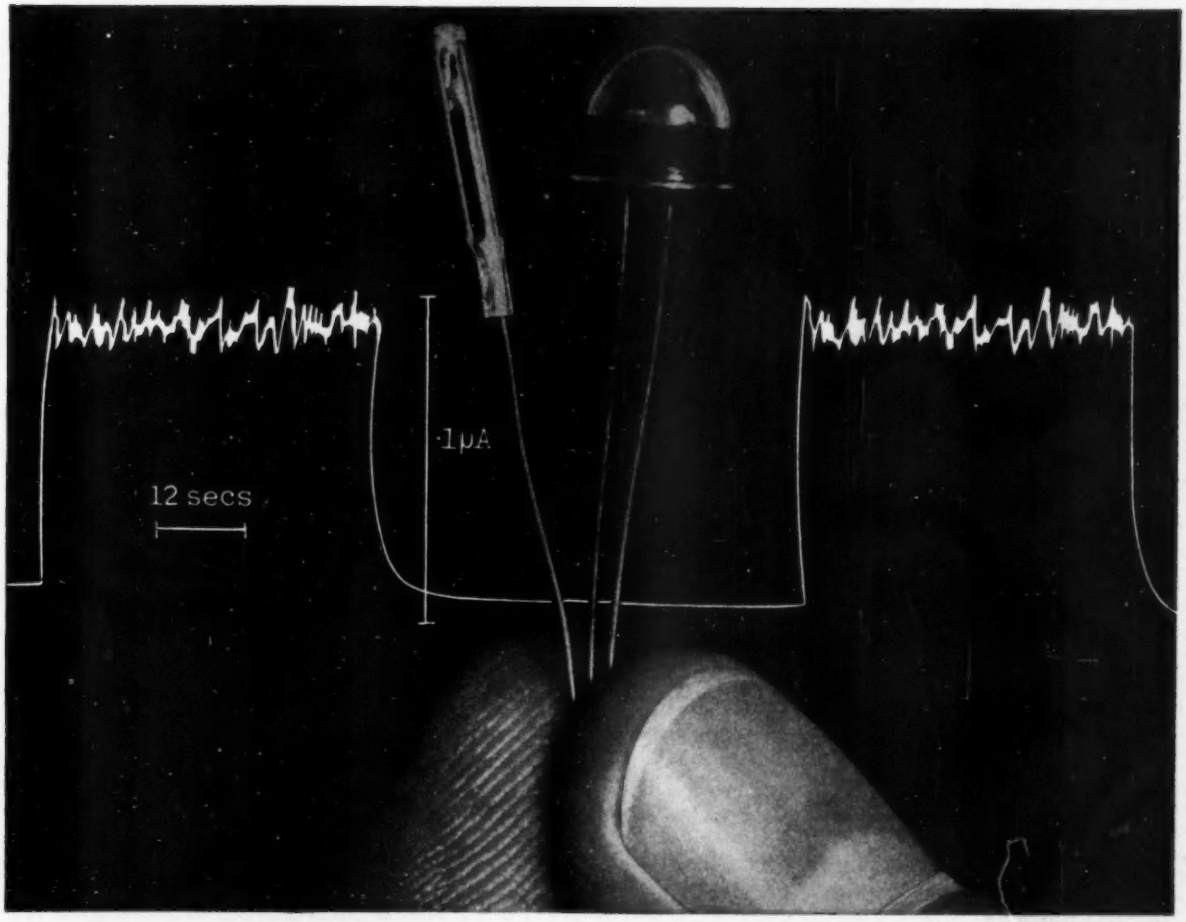
Yes? Then you'll want to know more about these particular types. We've produced them specially for detecting and measuring gamma-radiation. (They are also light-sensitive).

The standard cell, Type V 022 is a single cadmium crystal mounted horizontally on a header and hermetically sealed under a glass dome. In the Type V 021 the sensitive element is a single cadmium sulphide crystal mounted axially, close to the end of a thin-walled, vacuum-sealed glass tube for use as a probe.

The table below shows the sensitivity of the cells expressed both in terms of the total current passed by the crystal under gamma rays (flux at crystal — 1 Roentgen per min.) and the gamma current/dark current ratio.

Type	Total Gamma Ray Current	Gamma Current To Dark Current Ratio	Decay Time of True Gamma Current to 1/10th
V 022	< 0.1μA	< 10	> 8 sec
V 021 Group 1	< 0.2μA	< 10	> 8 sec
V 021 Group 2	< 0.03μA	< 30	> 2 sec

The cells have a linear response to voltage and may be used under a.c. or d.c. conditions up to 100v. peak. *We shall be happy to give you fuller information.*



EDISWAN INDUSTRIAL VALVES

Associated Electrical Industries Ltd
Radio & Electronic Components Division
Industrial Valve Department · 155 Charing Cross Road · London WC2
Tel: GERrard 8660 · Telegrams: Sieswan Westcent London

CRC 16/15

EE 30 168 *for further details*

MINIATURISATION

Miniaturisation in electronic components offers many advantages.

Small sized components are easy to handle, carry and store. Their use enables the overall equipment to be constructed so that valuable space is saved and the equipment is portable. Small plug-in replacement units facilitate servicing. Reduced size is particularly valuable in view of the increasing complexity of equipment.

Lightweight components have an obvious application where saving in weight is important. In addition, their low mass offers important advantages under conditions of shock, rapid change of acceleration and vibration.

Technical advantages are obtained using small components. A lower self-capacity and a lower interference pick-up may result. The components are more easily orientated, screened, potted and mounted in sealed containers.

The aesthetic appeal can be increased using miniature components. Greater freedom of arrangement for the designer is available and the incongruous relationship of size with the modern small transistor is avoided.

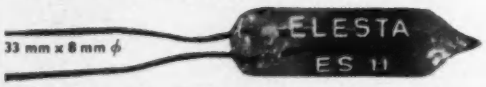
Ardente miniature components are playing a part in communications, navigation, defence, industrial electronics, business equipment, medicine, nucleonics, domestic equipment and general research. New, interesting designs and techniques are continually being developed resulting in miniature components which are widely used by Government bodies and Industry at home and abroad.

ARDENTE

ARDENTE ACOUSTIC LABORATORIES LTD 8-12 Minerva Road · North Acton · NW10 Phone: ELGar 3923

ELESTA

PRECISION COLD CATHODE TUBES



Sub-miniature Voltage Stabilizers & Reference Tubes with pure Molybdenum Cathodes

Stabilized Voltage for 2 mA	97	V
Anode Currents	0.5—8	mA
Internal Resistance	700	Ohms
Max. Variation during 20,000 hours	1	%

Data Sheets & Circuits supplied on Request

Distributing Agents: BRITEC LIMITED

17 CHARING CROSS ROAD, LONDON W.C.2 WHI 3070

EE 30 169 *for further details*

MORAWELON

ENGINEERING LIMITED

A SERVICE TO THE ELECTRONIC INDUSTRY

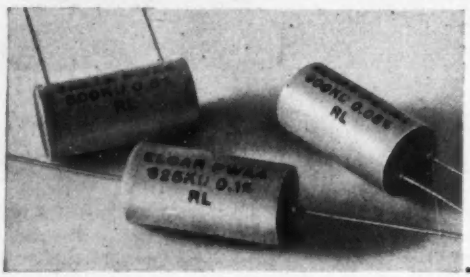
We can help you to meet your production and delivery promises in the field of Electronic Manufacture, Assembly, Wiring, Prototype Development, Cableforms and Component Encapsulation.
Contract or Sub-Contract work undertaken from One-Off to Regular Production Runs.

MORAWELON ENGINEERING LIMITED

Electronics Division, Brynymor Buildings, Morawelon Estate, Holyhead, Anglesey.
Phone: Holyhead 2046

EE 30 170 *for further details*

ELGAR PRECISION RESISTORS



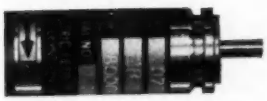
Light weight · Humidity Class H1
Tolerances 1% to **0.05%**

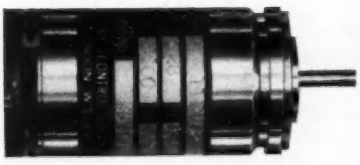
ELGAR LABORATORIES
(ELGAR TRADING LIMITED) *Established 1946*
23 Salisbury Grove · Mytchett · Aldershot · England
Phone: Farnborough (Hants) 2242 Cables: Elgatrad, Aldershot

EE 30 171 *for further details*

Vactric

DC Servo Motors





... a choice can be made from a wide selection of miniature precision built, low inertia, D.C. Servo motors in International frame sizes. These units conform to Ministry of Aviation Specification EL.1925 and incorporate stainless steel bearings.

The rating of all motors is continuous, they are reversible and can be used as generators.

Performance Data

SIZE 07.
Std. voltages 6, 12, 28. No load speed 13,000 r.p.m.
Torque 30 gm. cm. Min. stall torque 60 gm. cm.
Speed 8,000 r.p.m. Weight 40 gm.

SIZE 08.
Std. voltages 6, 12, 28. No load speed 8,500 r.p.m.
Torque 50 gm. cm. Min. stall torque 100 gm. cm.
Speed 5,000 r.p.m. Weight 60 gm.

SIZE 11.
Std. voltages 6, 12, 28. No load speed 8,500 r.p.m.
Torque 120 gm. cm. Min. stall torque 270 gm. cm.
Speed 5,000 r.p.m. Weight 145 gm.

SIZE 15.
Std. voltages 6, 12, 28. No load speed 7,500 r.p.m.
Torque 220 gm. cm. Min. stall torque 650 gm. cm.
Speed 5,000 r.p.m. Weight 305 gm.

SIZE 18.
Std. voltages 6, 12, 18. No load speed 7,000 r.p.m.
Torque 325 gm. cm. Min. stall torque 1,200 gm. cm.
Speed 5,000 r.p.m. Weight 450 gm.

All units can be supplied with plain shaft or with a pinion shaft permitting in-line reduction gearheads to be directly coupled, reductions up to 1,000,000:1 can be obtained with 2 gearheads in cascade.

** Write or telephone for literature dealing with our expanding range of Control Equipment.*

Vactric (Control Equipment) Limited

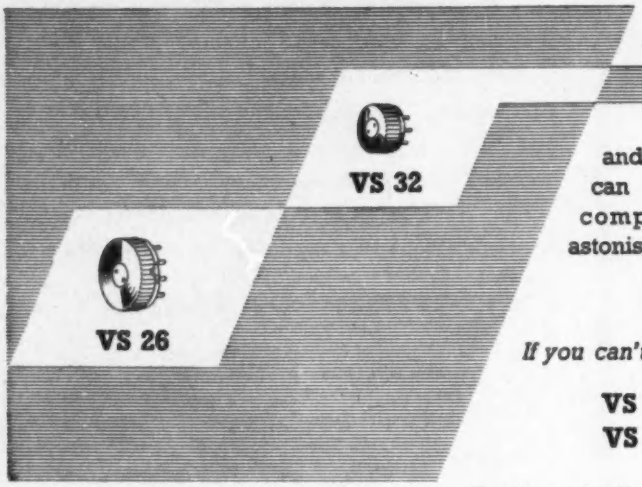
Vactric House, Sloane Street, London, S.W.1. Telephone BELgravia 7000

NAP 5008

EE 30 173 *for further details*

TWO LITTLE SO-LOWS

by FORTIPHONE



and worth a bit of a song, too, for we can now produce these very tiny, carbon composition volume controls in an astonishing range of resistance values, from

3 MΩ *down to* **10Ω**

If you can't believe your eyes, the actual sizes are :

VS 26 ·450″ dia. ·112″ thick
VS 32 ·312″ dia. ·150″ thick

That's not all — each has an on-off switch built in !

If you're interested we will gladly send full details

FORTIPHONE LTD. (Dept. 2) · COMPONENTS DIVISION · 92 MIDDLESEX ST., LONDON, E.1

MINIATURE STABILISED

POWER UNIT

TECHNICAL SPECIFICATION

Mains Input	*: 200-250v AC*
Outputs	*: Two 4-pin sockets*
Output DC Current	*: 0-100 mA shared between sockets*
Output DC Voltages	*: 150v 200v 250*
Regulation	*: 0·15% 0·025% 0·025%*
Voltage stabilization Ratio	*: 0·1/5 0·075/5 0·075/5*
Ripple	*: Less than 0·4mv RMS on full load*
AC Output	*: 6·3V, 2A at each socket*
Size	*: 5¼″ × 5¼″ × 5¼″*
Weight	*: Approximately 9½ lbs*
Delivery	*: Early delivery can be given*

PAMPHLET No. 1241b ON REQUEST

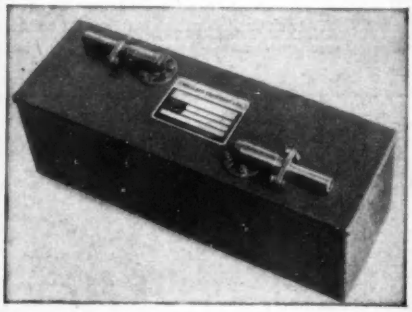
Other voltages within the range 150-250v can be supplied to order.
By means of simple links, one unit can provide any one of three output voltages.

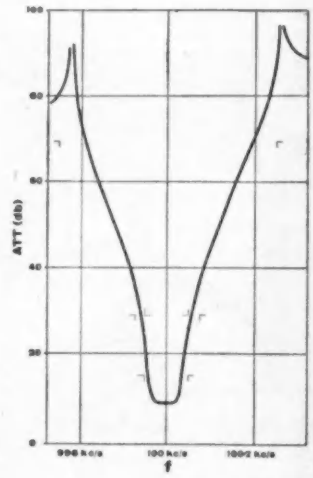
BARR & STROUD LTD. **ANNIESLAND, GLASGOW, W.3**
London Office: Kinnaird House, 1 Pall Mall East, S.W.1

EE 30 174 *for further details*

EE 30 175 *for further details*

Here is the answer to your filter problem





No matter how complex or difficult your filter problem, we can solve it.

Our specialist design team is constantly engaged in solving difficult filter problems and developing new circuits employing the latest crystal and L.C. techniques.

If you have a filter problem, just write to the address below. A wealth of experience will be at your disposal to provide the answer.

The typical response curve shown illustrates the exceptional performance of the Carrier-pass filter type YL3544, one of a range of 100 kc/s filters primarily intended for single sideband applications. This filter is remarkably compact for its outstanding performance, being only nine inches long.

MULLARD EQUIPMENT LIMITED

Mullard House · Torrington Place · London WC1
Telephone: LANgham 6633

ME 644

EE 30 176 *for further details*

A GREAT EGEN ADVANCE

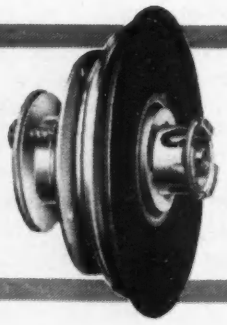
...SINGLE COMPONENT AERIAL ISOLATOR

EGEN have made possible aerial isolation in one compact, robust component! Look at these features:

* Minimum space occupied inside chassis
* Easily installed
* Complete co-axiality
* Complete effective screening
* Minimum effect on matching of Aerial feeder to receiver
* Insertion loss less than 0.3dB at 50 Mc/s.
* Multi-path resistors giving greater reliability
* All functional elements enclosed and protected against damage
* No soldered joints
* Accepts standard 0.202 in. O.D. co-axial cable
* Component parts are not subjected to heat from soldering iron

EGEN Type 364 Aerial Isolator

The illustration shows the component actual size.



Write now for full details to:

EGEN

ELECTRIC LTD

CHARFLEET INDUSTRIAL ESTATE
CANVEY ISLAND · ESSEX

WPS 67

EE 30 177 *for further details*

MILTOID SALES

DIVISION

BX PLASTICS LTD.

The British Xylonite Group.

STOCKISTS OF

BX POLYSTYRENE

Clear Crystal Standard Commercial Quality

A first-class rigid insulating material, supplied ex-stock in sheets and rods in a range of thickness and diameters.

•

Information and guidance on manipulation, machining and cementing available on request.

34 Royal College Street, London, N.W.1.
'Phone: EUSton 4146 'Grams: Celudol Norwest London

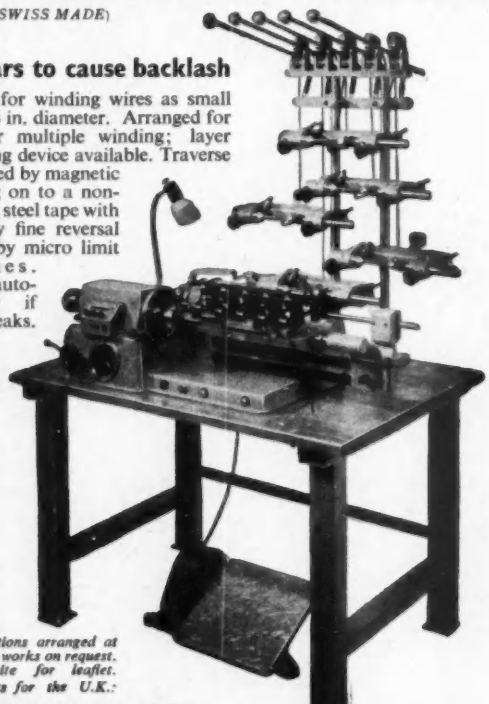
T.A.7853

METEOR COIL WINDERS

(SWISS MADE)

No gears to cause backlash

Suitable for winding wires as small as 0.0004 in. diameter. Arranged for single or multiple winding; layer shortening device available. Traverse is obtained by magnetic clamping on to a non-reversing steel tape with extremely fine reversal settings by micro limit switches. Stops automatically if wire breaks.



Demonstrations arranged at our London works on request. Please write for leaflet. Sole Agents for the U.K.:

ACBARS LTD.

57A HOLBORN VIADUCT, LONDON, E.C.1. CENtral 2287/8/9 - 6811/2

EE 30 178 *for further details*

..and now the R.44

-for piercing *through* Templates!

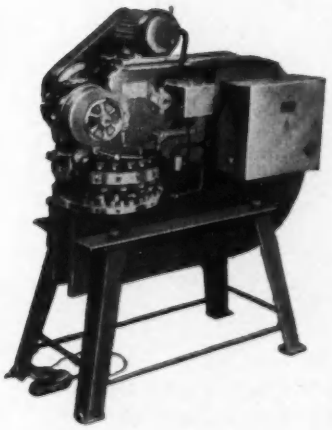
BRITISH

WIEDEMANN
Turret Punch Press

Piercing through templates, this new Wiedemann model gives faster than ever piercing on longer runs. Templates are fully protected — the press cannot trip until the punch has fully entered the template opening. Rack or standard gauges are available if required.

Punching Pressure ... ... 30,000 lb.
Throat depth 28" ... 1 HP. Motor
16, 18 or 20 turret stations

There's a Wiedemann Turret Punch Press for every short and medium run piercing job. Hand or power — 15,000 to 160,000 lb. punching pressure.



Write for the new Wiedemann Brochure.

DOWDING & DOLL LTD
346 KENSINGTON HIGH STREET, LONDON, W.14
Telephone: WESTERN 8077 (8 lines) Telegrams: ACCURATOOL HAMMER LONDON

143

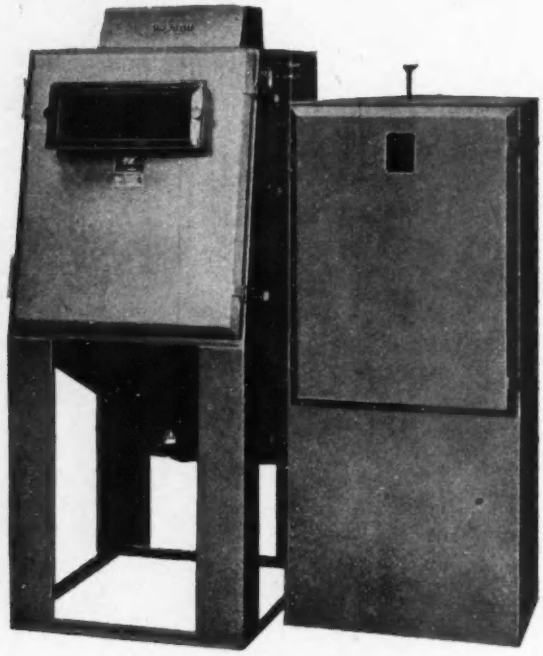
EE 30 180 *for further details*

At Last!

AUTOMATION COMES TO LIGHT INDUSTRIAL SHOTBLASTING

with the

T/40 GUYROTA



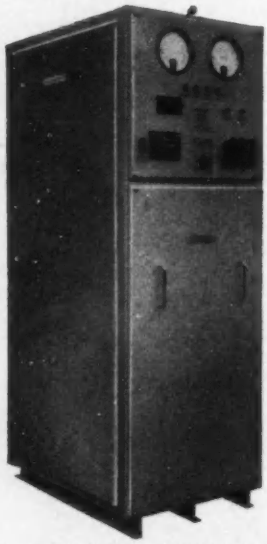
Ideal for manufacturers who need to rapidly blast clean large quantities of small metal parts or De-Flash Thermo-set Plastic Mouldings. All the operator does is load the tumbler on to the angled turntable and let it rotate under the blaster gun for a pre-determined length of time. Manpower is saved by having one operator to a number of Guyrotas.

Send today for Bulletin T/40(c).

Guyson Regd

GUYSON INDUSTRIAL EQUIPMENT LTD.

North Avenue, Otley, Yorks. Tel: Otley 2456. Grams: "Guyson Otley"



A TYPICAL 30 KILOWATT STABILISED D.C. POWER UNIT

CAYTEL

STABILISED D.C. POWER UNITS

AS LARGE AS 30 KILOWATTS OR AS SMALL AS A FEW WATTS!

- FOR ALL TELEPHONE APPLICATIONS
- APPROVED FOR P.O. USE
- UNAFFECTED BY WIDE VARIATIONS OF FREQUENCY INPUT VOLTAGE AND LOAD CURRENT BETWEEN MAXIMUM AND ZERO
- FREE FROM CYCLIC MODULATION
- HIGH EFFICIENCY
- SUITABLE FOR USE WITH GENERATORS HAVING FREQUENCY FLUCTUATIONS OF ±20%
- NO MOVING PARTS OR VALVES

CAYSON ELECTRICS LTD.

WATFORD

Telephone: WATFORD 27452, 29159, 27156

EE 30 181 *for further details*

EE 30 182 *for further details*

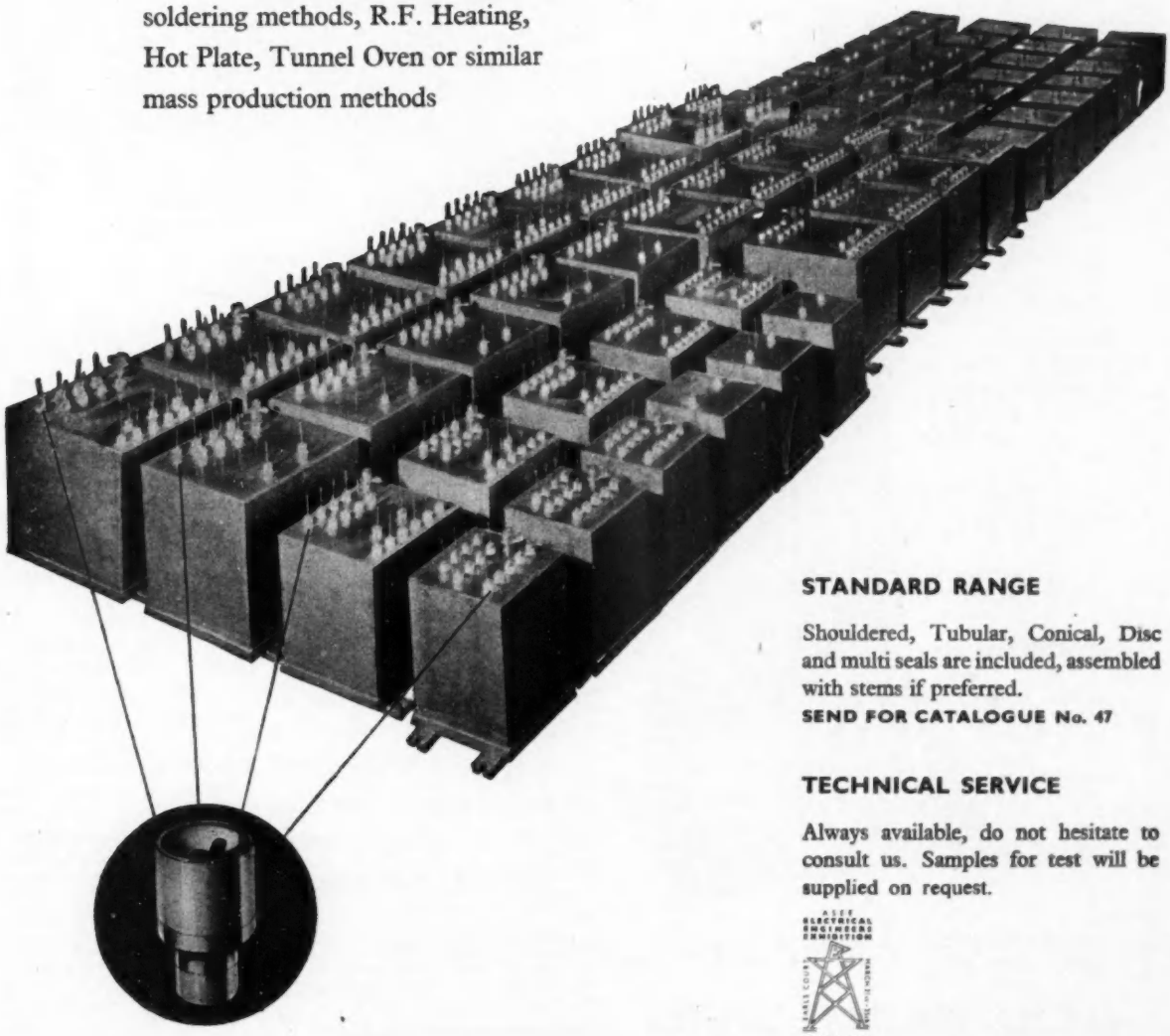
Hermetic Sealing

STEATITE & PORCELAIN
NICKEL METALLISING
Quality Approved (Joint Service R.C.S.C.)
WILL MEET THE MOST EXACTING REQUIREMENTS

METALLISED BUSHES

Perfect Terminations

—made readily without special precautions by semi-skilled labour, employing simple hand soldering methods, R.F. Heating, Hot Plate, Tunnel Oven or similar mass production methods



STANDARD RANGE

Shouldered, Tubular, Conical, Disc and multi seals are included, assembled with stems if preferred.
SEND FOR CATALOGUE No. 47

TECHNICAL SERVICE

Always available, do not hesitate to consult us. Samples for test will be supplied on request.

STEATITE & PORCELAIN PRODUCTS LTD.

STOURPORT ON SEVERN, WORCS. **Telephone: Stourport 2271.** **Telegrams: Steatain, Stourport**

SP100

Soldering Instruments and Equipment

ADCOLA PRODUCTS LIMITED (Regd Trade Mark)

Illustrated

$\frac{1}{16}$ in. DET. BIT MODEL L64 PROTECTIVE UNIT COMPLETE WITH SOLDER BIT

CLEANING ACCESSORIES L700

ALL VOLT RANGES 6/7 to 230/50 VOLTS

British & Foreign Pats. & Reg. designs.

For further information and full illustrated catalogue apply head office.

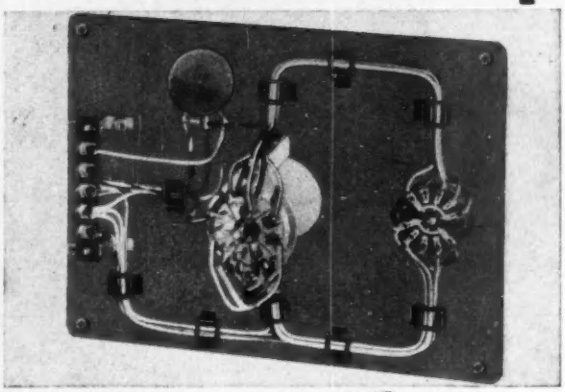
ADCOLA PRODUCTS LIMITED

GAUDEN ROAD, CLAPHAM HIGH STREET LONDON, S.W.4

Telephones: MACaulay 3101 and 4272 *Telegrams: SOLJOINT*

When the wiring's very small here's the finest tip of all...

Cradleclip



miniature Insuloid cradleclip

Comparison with a three-penny piece gives some indication of the very small size.

Specially designed for Electronics and all very small runs to give all the well known advantages of the Cradleclip Wiring System.

WITH ALL THESE ADVANTAGES

- ★ Cuts wiring time by 52%.
- ★ Combines high speed fixing with simplicity and security.
- ★ Brings a new versatility, compactness and neatness to your wiring.
- ★ Completely insulated and suitable for all climates.
- ★ Electrical and mechanical security in all conditions.

The Cradleclip System has been

- ★ Proved in wiring installations throughout the world.
- ★ Wiring modifications are quickly and easily carried out.

Send for fully descriptive literature on the Insuloid Miniature Cradleclip Wiring System now, and find out also about other Insuloid time and money saving products.

Twice as good
Twice as quick
when you wire
with CRADLECLIP

INSULOID MANUFACTURING CO. LTD.

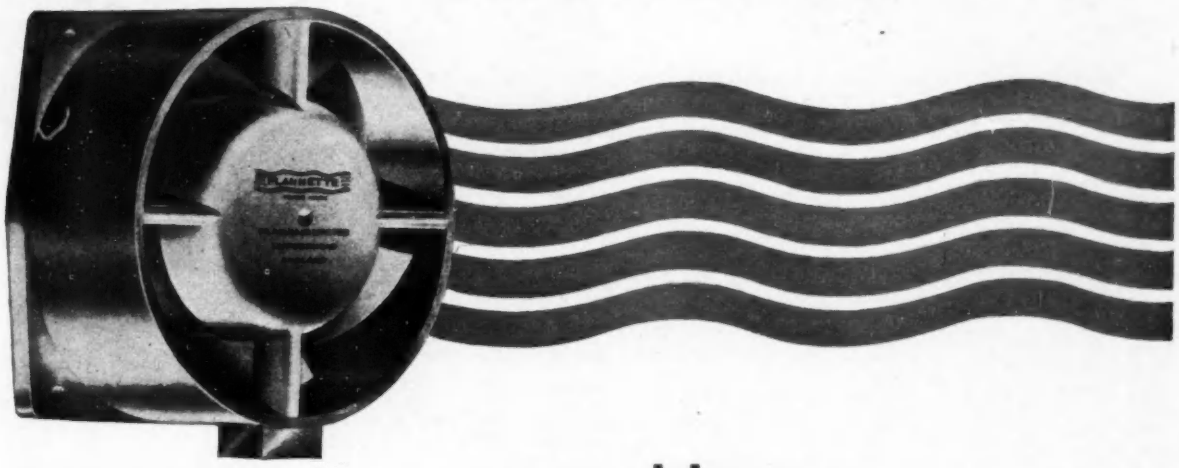
Sharston Works, Leestone Road, Wythenshawe, Manchester.

Tel: Wythenshawe 2842 & 3163.

Come and see us on Stand Z11 at the A.S.E.E. Exhibition, Earls Court.

EE 30 185 *for further details*

meet the [redacted] PLANNETTE



—it's only 2" deep

...a new blower for forced air cooling in confined spaces

Here, for the first time, is a blower that makes efficient forced air cooling in confined spaces a practical proposition. In the new PLANNETTE the entire fan assembly is only 2" deep and this makes it ideal for projects such as computers, electronic black boxes, mobile radios, or electronic instruments. The PLANNETTE can be mounted either inside or on top of the cabinet and thus it makes cooling possible where space is insufficient to fit a conventional blower. Its performance is quite exceptional. Write now for detailed leaflet.

DESCRIPTION

The new 'Plannette' fans are available in two sizes, 4½" and 6" diameter. The casing is light alloy, die cast, and the impeller blades, which are of a special aerofoil section, are moulded plastic.

The motors are a.c. and may be arranged either for 230V 1-ph. 50 cycles or 110V 1-ph. 50 cycles. The nominal operating speed is 2,700 r.p.m. Noise level is extremely low.

PLANNAIR

PLANNAIR LIMITED

Windfield House • Leatherhead • Surrey
Tel: Leatherhead 4091/3, 2231

PLA 52

EE 30 186 *for further details*

99·9999%

The production of semiconductors and of intermetallic compounds for thermoelectric devices has resulted in a demand for very high purity metals. To meet these developments, The Consolidated Mining & Smelting Co. of Canada Ltd., is producing the following metals to purities of the order of 99.9999%:

BISMUTH · CADMIUM · INDIUM · LEAD · SILVER · ZINC

These "TADANAC" Brand metals are available in the United Kingdom and Europe from

HENRY GARDNER

AND COMPANY LIMITED

2 METAL EXCHANGE BUILDINGS · LEADENHALL AVENUE · LONDON · E.C.3

Telephone: MANsion House 4521.

whose Technical Service Department, backed by the full resources of the producers' Research Division, will welcome enquiries.

ELECTRONIC FUNDAMENTALS AND APPLICATIONS

by John D. Ryder

The author has consolidated the fundamental phenomena underlying both the transistor and semi-conductor devices into one treatment. In addition, he has brought together electronics and basic network theory and has emphasized the standard methods that prevail once an electronic device is reduced to a linear active circuit; the treatment generally is qualitative and emphasis is given to the basic properties of an analytic method or process **60s. net.**

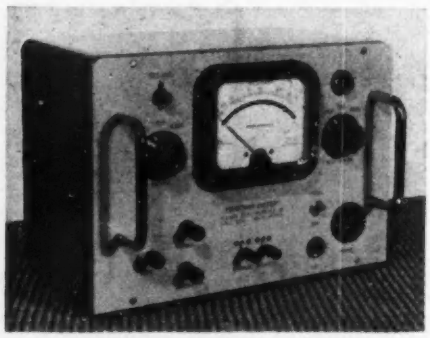
From all Booksellers

PITMAN Parker St., Kingsway London, W.C.2

EE 30 187 *for further details*

MEGOHM METER . . .

20 MEGOHMS TO 50,000 MEGOHMS STANDARD.
OTHER RANGES TO ORDER



MEGOHM METER LS187-E

PRICE

£65

- **PORTABLE**
- **SELF CONTAINED**
- **MAINS OPERATED**

Enables unskilled operators to read insulation resistance direct in megohms in the laboratory, in the factory or on location. Readings independent of mains fluctuations and measuring circuit inherently safe against accidental overloads.
The Altron Megohm Meter is used extensively by industrial operators and by research organisations throughout the U.K. and overseas.

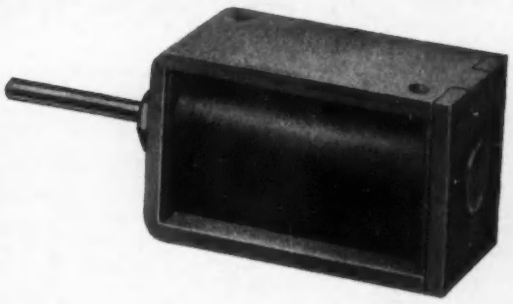
ALLIED ELECTRONICS LTD.

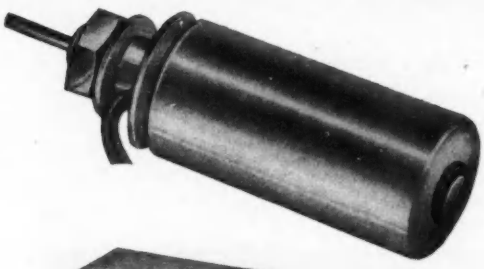
28 UPPER RICHMOND ROAD, LONDON, S.W.15

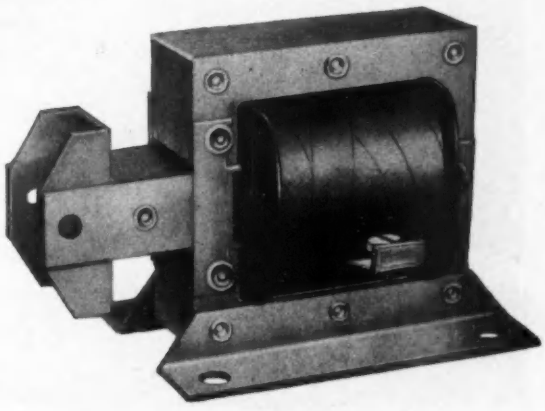
TELEPHONE: VANDYKE 1856

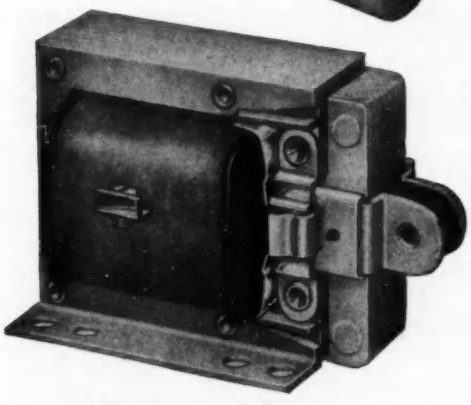
EE 30 188 *for further details*

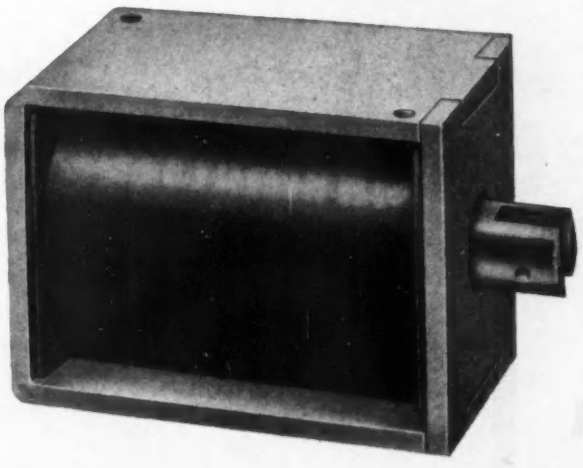
ELECTRO METHODS LTD

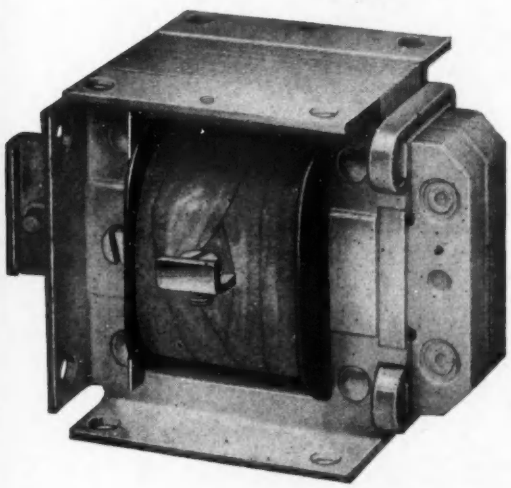












A FULL RANGE OF A.C. & D.C.
SOLENOIDS

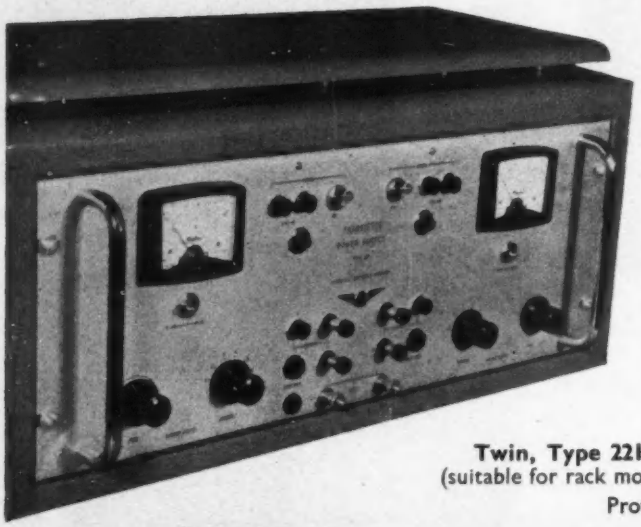
PROMPT DELIVERY

Illustrated technical data sent on request:

ELECTRO METHODS LTD., General Products Division, CAXTON WAY, STEVENAGE HERTS.
Telephone: Stevenage 2110-7

EE 30 190 *for further details*

MARSHALL



STABILISED TRANSISTOR POWER SUPPLIES

0-30V Continuously Variable

1 Amp Continuous Rating at all Voltages

Ripple approx. 1 Millivolt Peak-to-Peak

Twin, Type 221, £99
(suitable for rack mounting)

Single, Type 222, £59
(10 Amp, Type 223, also available)

Protection Circuits optional extra

Enquiries to Sales Department
MARSHALL OF CAMBRIDGE ELECTRONICS LIMITED
THE AIRPORT, CAMBRIDGE, ENGLAND

ZENITH
Reg. Trade Mark

Variac
Reg. Trade Mark

the original continuously-adjustable autotransformer

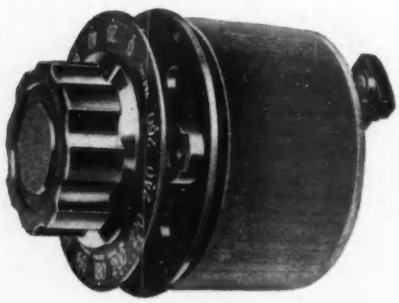
with the Exclusive
Duratrak
Reg. Trade Mark. Pat. 893466
Contact Surface

A small model with the qualities of the larger sizes. Available at an economic price allowing its frequent use for voltage control down to zero in conjunction with heaters and other apparatus having loadings up to 270vA at 240 volts.

The usual over-voltage feature is standard giving 0-270 volts at 1 ampere.

It is suitable for bench or panel mounting, and is also offered as an enclosed type ('V3HM'), ganged, motorised, and in other style variations.

Our Catalogue VAR-5 gives details on page 4 and includes over 300 other models. Has a copy reached you?



Model 'V3H'
270vA
Input 240V 50 cycles
Output 0-270V 1 ampere

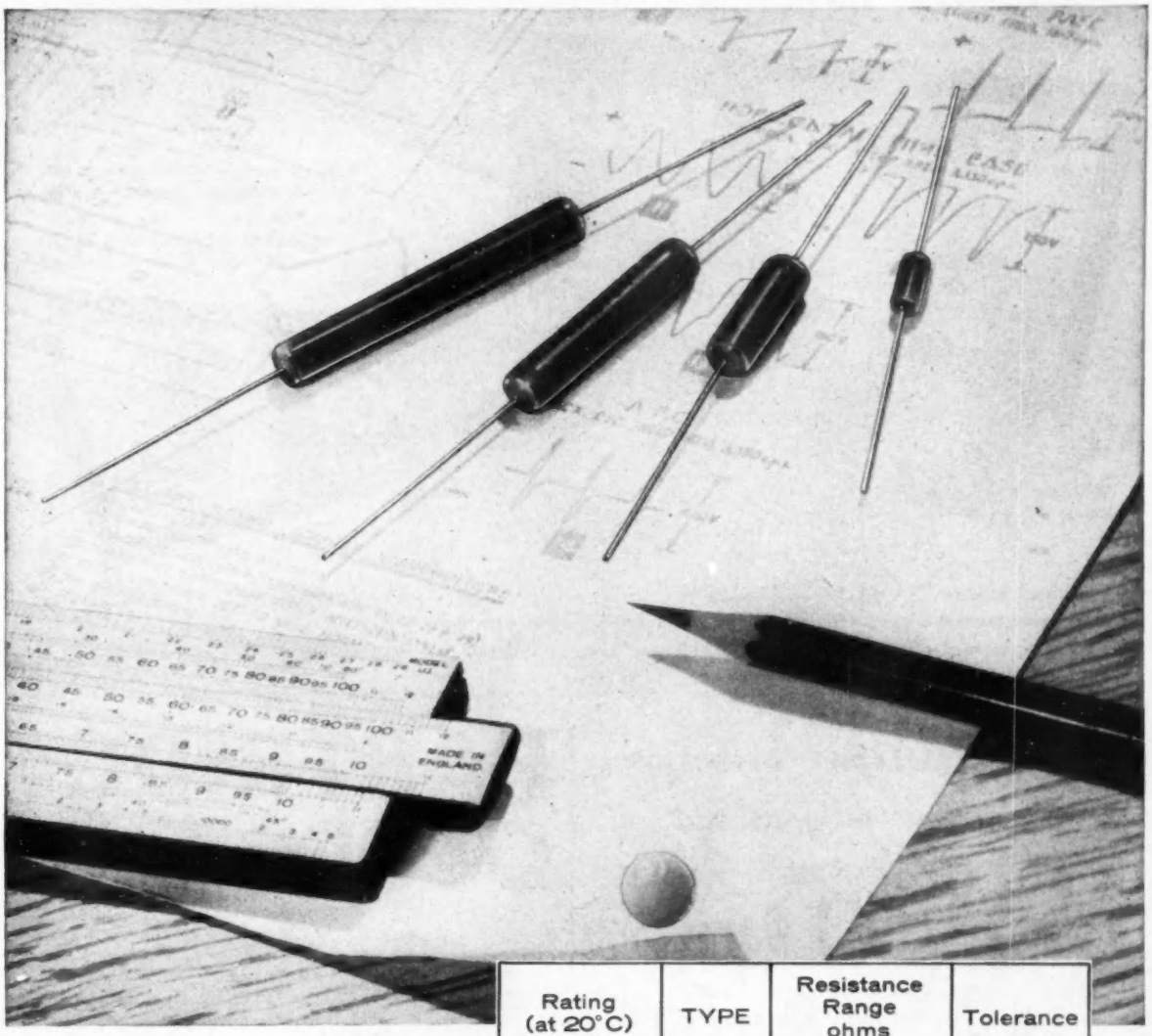
THE ZENITH ELECTRIC COMPANY LTD.

ZENITH WORKS VILLIERS ROAD WILLESDEN GREEN LONDON N.W.2
Telephone: WILlesden 6581-5 Telegrams: Voltaohm, Norphone, London
MANUFACTURERS OF ELECTRICAL EQUIPMENT INCLUDING RADIO AND TELEVISION COMPONENTS

EE 30 191 *for further details*

EE 30 192 *for further details*

PAINTON Miniature Vitreous Wirewound Resistors



Rating (at 20°C) Watts	TYPE	Resistance Range ohms		Tolerance
		Min	Max	
4	MV1A	1 10	9·9 6,800	10% 5%
7	301A	2	68,000	5%
10	302A	4	140,000	5%
5	306A	1	33,000	5%

Protected by Patent Nos. 626128 & 575279

PAINTON

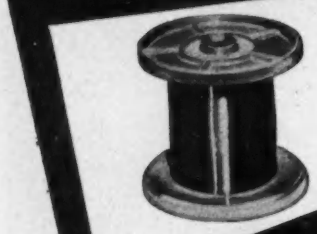
★ Fully Type Approved to RCS 111
★ Top Quality ★ Quick Delivery
★ Competitive Prices

Painton & Co. Ltd.
KINGSTHORPE NORTHAMPTON
Tel: 34251 (10 Lines) Telegrams: 'Ceil Northampton'
Telex: 31576

Always specify Painton Wirewounds

EE 30 193 *for further details*

High precision resistance wire



VACROM
NICKEL-CHROME

These 'Vacrom' and 'Eureka' high precision fine and superfine wires are provided to meet the most accurate demands of the electrical industry. They can be supplied fully annealed in either a bright or oxidised finish in accordance with B.S. or to meet the customer's own specifications.

EUREKA
CUPRO-NICKEL

* *Supplied bare or with standard coverings of cotton, silk, rayon, enamel and glass.*

THE LONDON ELECTRIC WIRE CO. & SMITHS LIMITED · LEYTON · LONDON, E.10

VACTITE WIRE COMPANY LIMITED · LINACRE LANE, BOOTLE 20 · LANCS.

L·E·W · VACTITE

L.V.5

Springing to your aid

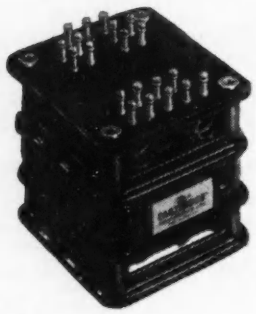
Contractors to the Car Industry

40 years experience together with all up-to-date facilities, in the art and production of Coil Springs, Presswork, and Wirework, are at the disposal of established and potential customers.

CLARKES (Redditch) LTD
Sinew Works · REDDITCH · Worcs
Tel: 2672 (4 lines)

EE 30 194 *for further details*

PARTRIDGE C-CORE TRANSFORMERS



7 days to produce prototypes

Telephone us when you need a prototype in a hurry. An engineer can be with you in a few hours.

There are few, if any, industrial transformer applications which are not covered by one of the types in the comprehensive Partridge Range. Our scope includes all types of electronic transformers, open and hermetically sealed, air cooled and oil immersed.
Type Approval Certificate No. 1295 for H.S. C-Core RANGE.
New and better types are always being added—the C-Core Transformer above is an example. Whatever you need in the transformer field, our catalogue should be on your desk. Contact us now.

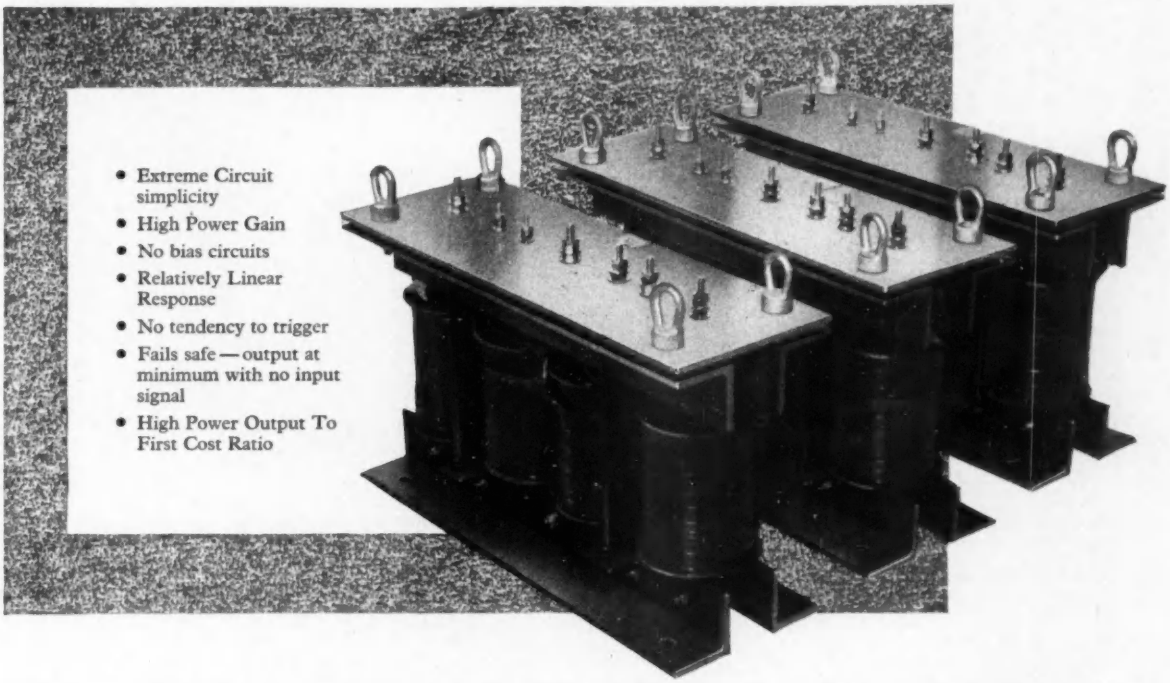
Partridge TRANSFORMERS LTD.

Roebuck Road, Chessington, Surrey. *Phone: Elmbridge 6737-8.*

EE 30 195 *for further details*

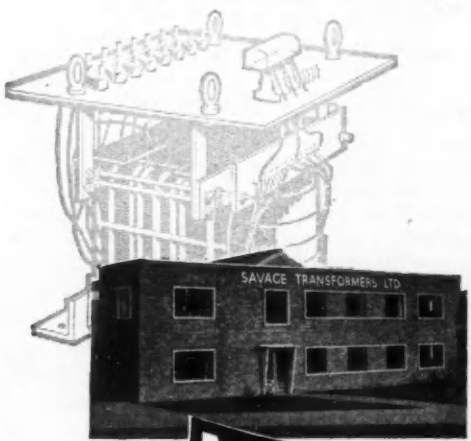
SAVAGE

Massicore transductors



- Extreme Circuit simplicity
- High Power Gain
- No bias circuits
- Relatively Linear Response
- No tendency to trigger
- Fails safe — output at minimum with no input signal
- High Power Output To First Cost Ratio

—the most economical and trouble-free method of Stepless Power Control



Illustrated are some of the new Savage Massicore Transductors for stepless power control. These provide the most economical and trouble-free method yet devised for controlling large blocks of electrical power for heating.

Available in a large range of sizes covering from one to fifty KVA—(one hundred and fifty KVA on three phase)—these components present a ready solution to many control problems.

There is also a "fail safe", no bias, magnetic pre-amplifier which functions on an input signal of 100 m/watts max.

If you have a control problem, however complicated or simple, write to

THE LITTLE FACTORY
WITH THE BIG REPUTATION

SAVAGE TRANSFORMERS LIMITED
NURSTEED ROAD, DEVIZES, WILTS

Tel: Devizes 932

SAVAGE MASSICORE

T.P. 74

EE 30 197 *for further details*

For attenuation with PRECISION

Hatfield

VARIABLE

VHF ATTENUATOR TYPE Q

Designers and Electronic Engineers will welcome this new precision-made Hatfield Attenuator, available for either 0–11dB in 1dB steps or 0–110dB in 10dB steps and covering DC—500 Mc/s. Models are also available for Ledex Drive.

- **V.S.W.R. 1.2 below 250 Mc/s.**
- **Matched at all attenuations.**
- **Low operating torque.**
- **Rated at 0.5 W.**
- **50 ohm and 75 ohm models available.**
- **Size; 5¼ in. × 1⅞ in. × 2⅝ in.**
- **Weight; 1½ lbs. Price £36.**

The wide range of high quality Hatfield Instruments includes:

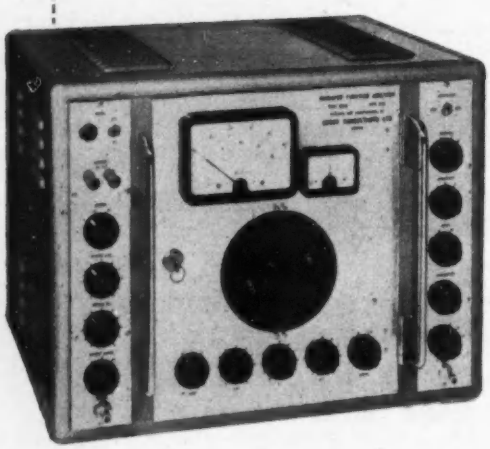
- **RF Bridge**
- **Stabilised D.C. Power Unit.**
- **D.C. Amplifier • A.C. Power Supplies.**
- **Transistorised Temperature Controller.**
- **Coaxial Switches • Valve Millivoltmeter.**
- **Balanced Crystal Modulator.**

Hatfield INSTRUMENTS LTD. | Balun LTD. *First with Wide Band R.F. Transformers.*

Write for full details of this and other Hatfield Instruments.

Dept. EE, BURRINGTON WAY, PLYMOUTH, DEVON. *Telephone: Plymouth 72773 Telegrams: SIGJEN PLYMOUTH*

A sample from our range of servo test gear . . .



TRANSFER FUNCTION ANALYSER TYPE 123S

This versatile instrument features within a single cabinet:

Direct indication of phase angle
Direct indication of amplitude
Test frequency range: 0·03-250c/s
Decade setting of test frequency
Modulated carrier or DC output
Decade output attenuator
Carrier frequency range 50c/s-3KC
Independent AC or DC input
High sensitivity input: 50mV
Mechanical output
Instantaneous Start-Stop facility

★ *We also manufacture:*
Very Low Frequency Generators
Automatic Nyquist Diagram Plotters
Stabilized AC Servo Power Supplies
Control System Teaching Aids
Instrument Servo Gearboxes
Industrial Control Gear

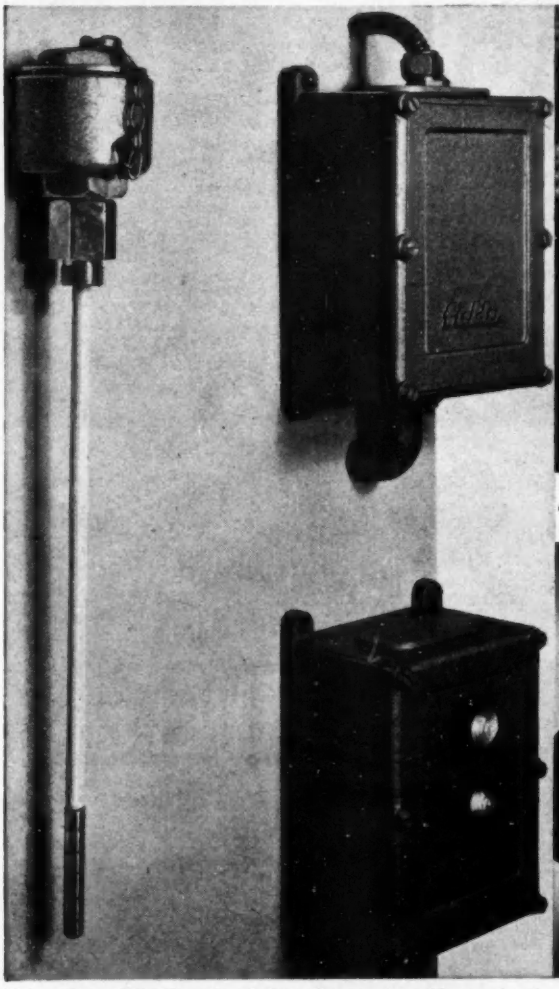
SERVO CONSULTANTS LIMITED

10 BOUVERIE PLACE · LONDON · W.2.

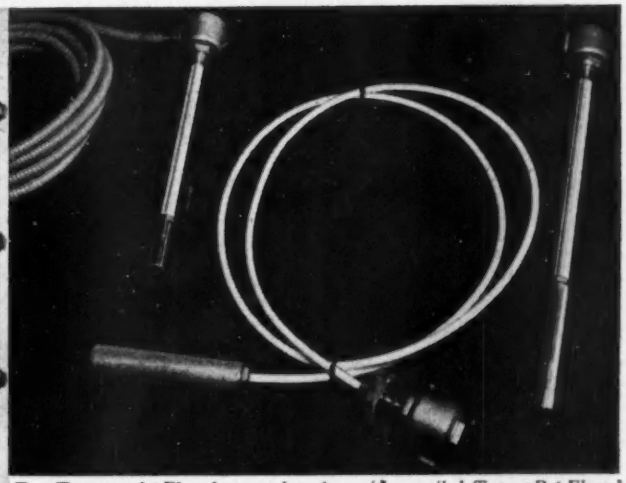
Paddington 2811

EE 30 198 *for further details*

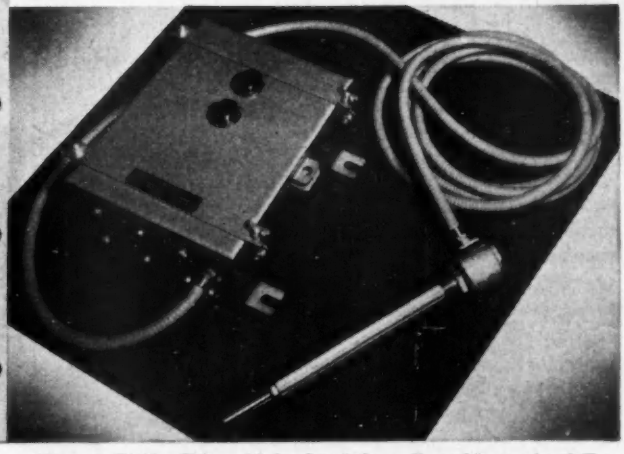
'FLUON' INCREASES PRODUCTION EFFICIENCY IN INDUSTRY



Tektor Type TT5 Transistorised level controller with associated lamp unit and type 9B 'Fluon' covered probe made by Fielden Electronics Ltd.



Two Type 24 A 'Fluon' covered probes with a coiled Type 9B 'Fluon' covered Telstor probe made by Fielden Electronics Ltd., Wythenshawe, Manchester.



The new Fielden Tektor Major Level Controller, with associated Type 24 A 'Fluon' covered probe made by Fielden Electronics Ltd.

Fielden Electronics Limited use 'Fluon' to cover probes for their electronic control equipment

Fielden Tektor Level Controllers and Telstor Level Indicators operate on the capacitance principle and consist of an electronic unit and a probe, which is inserted into the container at the point at which control is required. The principle of operation does not require the substance being controlled to touch the metal probe, which can therefore be covered with an anti-corrosive, heat resistant insulation.

'Fluon' p.t.f.e. is used as a covering for probes to be used at temperatures up to 320°C. because of its excellent dielectric properties and its virtual immunity to attack from most chemicals up to this temperature. Its anti-wetting properties also prevent a film of liquid forming on the probe which, if allowed, could produce a false reading. 'Fluon' is a tough, flexible material with the lowest coefficients of friction of any solid.

'FLUON'

'Fluon' is the registered trade mark for the polytetrafluoroethylene manufactured by I.C.I.

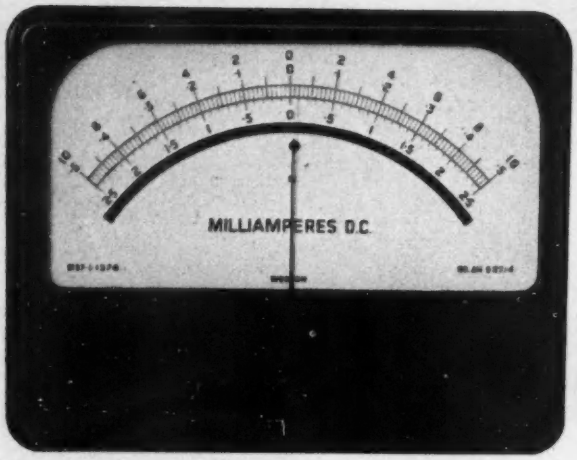
IMPERIAL CHEMICAL INDUSTRIES LIMITED · LONDON · S.W.1

ICI

FP65

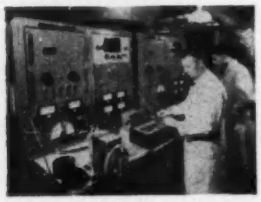
EE 30 200 *for further details*

meters made to measure



special multi-range meter produced for Ultra in 14 days

The Anders Instrument Centre is in a unique position to meet the most urgent, and the most unusual, meter requirements from production, development and research. Most standard meters are available immediately from stock. Non-standard meters are calibrated, tested, and normally ready within 10-14 days. All shapes; sizes from 1½" to the largest switchboard meters. All well-known makes and all types including moving coil, moving iron, thermocouples, electrostatic, dynamometers and full range of meter accessories. Anders would like to demonstrate the kind of service they can give you and look forward to your enquiries, by letter or by telephone.



This multi-range meter, using Sangamo Weston S.157, is one of several similar instruments produced by Anders for Ultra Electronics Limited within 14 days. The meters are used in Ground Test Equipment supplied to B.O.A.C. (shown left) for testing the Ultra Engine Throttle Control fitted in Bristol Britannia Aircraft. A typical example of the quick service Anders are giving to many famous firms. Anders are indebted to Ultra Electronics Limited and B.O.A.C. for permission to illustrate this equipment.

ANDERS

ELECTRONICS LIMITED

103 Hampstead Road, London NW1. Tel: EUSton 1639

Contractors to GPO and Government Departments.
Ministry of Aviation approved.

METERS, ELECTRONIC AND TEST EQUIPMENT TO INDIVIDUAL SPECIFICATIONS

EE 30 201 *for further details*

COLVERN

Specialists in the manufacture of Wirewound Potentiometers for over 30 years. COLVERN LIMITED are the foremost producers of these components in the United Kingdom.
The extensive range of types in constant production comprises:

- ***Standard Wirewound Potentiometers from 1 to 15 watts rating and including multi-ganged types.***
- ***A complete range of sealed wirewound potentiometers and variable resistors conforming to British Joint Service Specifications RCS/121 and RCL/121.***
- ***A comprehensive range of Precision Potentiometers, including Helical and Sine/Cosine types, many incorporating the exclusive COLVERN Cam-correction Device.***

Wire Wound

TYPE CLR4201
SEALED TROPICAL POTENTIOMETERS
Designed to operate under extreme climatic conditions and to meet the requirements of British Joint Service Specifications RCS. 121. The potentiometer is housed in a mineral filled moulding, and effectively sealed by a metal back cover and neoprene 'O' seals in the spindle-bush assembly. CONFORMS TO BRITISH INTERSERVICE SPECIFICATIONS RCS.121 AND RCL.121, STYLES RAC-RAD(CLR.4239), RAE-RAF (CLR.5237) HUMIDITY CLASS H2.

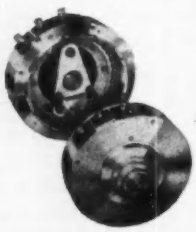
POTENTIOMETERS

Type CLR.26/00 MULTI-TURN Helical Potentiometer has been developed primarily for mechanical drive and use in servo systems. Supplied in the popular 10-turn version, or with any number of turns in the helix from 3 to 20, standards being 3-5-10-15 and 20 turns. The precision-ground stainless steel shaft is mounted in ballraces giving a smooth torque of 1-1½ oz./in. and the machined duralumin base has a locating spigot true with the shaft.

SPECIFICATION:

- ***Rating: 0.4 watts per turn • Resistance Range: 10 Ω-10k Ω per turn.***
  Resistance Tolerance: Standard, ±5%. Best Practical, ±1%.
- ***Absolute Law Accuracy: Std., ±0.25% } 10-turn***
  Spec., ±0.1% } turn
- ***Max. Working Volts Spindle/Track 1000V D.C.***
- ***Effective Resistance Angle Tol.: ±1°. • Max. Starting Torque: ½ oz./in.***
- ***Min. Angle between Taps: 90°.***
- ***Max. Ganged Sections: 2.***

For High Accuracy



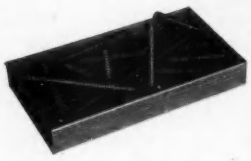
TYPE CLR.91.00
CAM CORRECTED
Originally developed for Radar Gunnery Equipment this Potentiometer is undoubtedly the most accurate Potentiometer in quantity production. In addition to applications in Electronic Computing it is an ideal instrument for use as a laboratory standard.

SPECIFICATION:

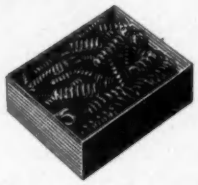
- ***Rating: 10 watts • Resistance Range: 1000 Ω-150k Ω • Resistance Tolerance: Standard ±5%. Best Practical, ±1%.***
- ***Absolute Law Accuracy: ±0.04%.***
- ***Max. Working Volts Spindle Track: 1000V D.C. • Effective Resistance Angle: 315° +25°−0°.***
  Mechanical Rotation: 360° cont. • Max. Starting Torque: 8.5 oz./in.
  Min. Angle between Taps: 10°.
  Max. Ganged Sections: 4.

COLVERN LTD., SPRING GDNS., ROMFORD Telephone ROMFORD 62222 ESSEX
Telegrams & Cables COLVERN PHONE ROMFORD

EXPERIMENTAL SPRINGS?

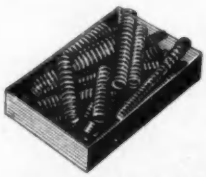


No. 1200. Three dozen Assorted Light Expansion Springs, suitable for carburettor control, etc. **13/6.**



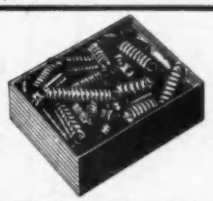
No. 98A. Three dozen Assorted 1″ to 4″ long, ⅛″ to ⅜″ diam., 19G to 15G. **5/6.**

No. 753. Three dozen Assorted Light Expansion ¼″ to ½″ diam., 2″ to 6″ long, 22 to 18 S.W.G. **10/6.**



No. 760. Three dozen Assorted Light Compression Springs. 1″ to 4″ long, 22 to 18 S.W.G., ¼″ to ½″ diam. **6/6.**

No. 757. Extra Light Compression, 1 gross Assorted, ⅛″ to ¼″ diam., ½″ to 2½″ long, 27 to 19 S.W.G. **15/-.**



No. 758. Fine Expansion Springs. 1 gross Assorted ¼″ to ⅜″ diam., ½″ to 2″ long, 27 to 20 S.W.G. **15/-.**

That spring you want . . . in a hurry . . . *where* is it? Pick *what* you want *when* you want it from TERRY'S BOXES OF ASSORTED SPRINGS—our fine range of small boxed assortments of experimental springs. We can show you only a few from the range here. Send a postcard for our full list—and if ever you're stuck with a spring problem send it along to our Research Department —they'll gladly help you out.

Have you a Presswork problem?

If so, the help of our Design Staff is yours for the asking.

TERRY'S *for SPRINGS*

Really interested in Springs? "Spring Design and Calculations" 10th Edition tells all—post free 12/6.

Cut Production Costs with Terry's Wire CIRCLIPS. We can supply immediately from stock—from ⅛″ to ⅜″.

Looking for good Hose Clips? Send for a sample of Terry's Security Worm Drive Hose Clip and price list.

HERBERT TERRY & SONS LTD

Redditch, Worcs.

(Makers of Quality Springs, Wireforms and Presswork for over 100 years)

HT31

EE 30 203 *for further details*

Machine Capacity and Capable hands

AT YOUR SERVICE

For the Manufacture of

PLASTIC

PRODUCTS & COMPONENTS

FOR ANY INDUSTRY

CAPACITY:—

1. Plastics
   (a) Injection Moulding to 10 lb by weight and all materials.
   (b) Compression and Transfer. All phenolic, urea and dough moulding compounds.
   (c) Blow Moulding of thermo-plastic materials.
   (d) Vacuum forming.
   (e) Extrusion (all kinds of sections and rounds). Lay flat blown film.
   (f) Ferrous and non-ferrous machined and pressed parts.
2. Spraying. Embossing and Printing on plastic.
3. Complete assemblies.
4. Tools designed and made.

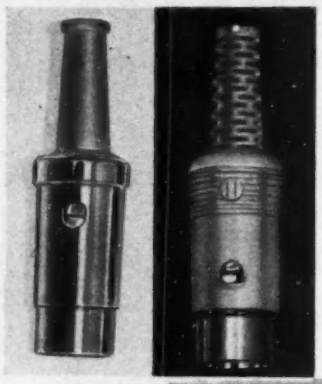
THE CO-ORDINATORS SERVICE (ENGINEERING) LTD

SHADY LANE · BIRMINGHAM 22A · Telephone: GREat Barr 4237

EE 30 204 *for further details*

The comprehensive range of

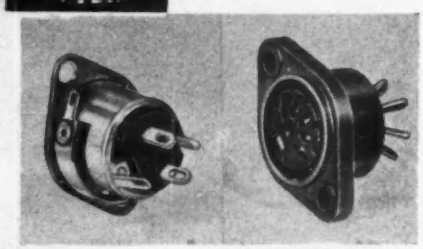
HIRSCHMANN



PLUGS
SOCKETS
TERMINALS
AERIALS
ETC.

is now available

★ Fitted as standard by leading manufacturers in W. Germany and other countries



Full details and catalogue from sole U.K. agent

NEOFLEX LTD.

123a NEASDEN LANE, LONDON, N.W.10

Tel: GLADSTONE 2718 & 4075

Mechanical Relay Latch

FOR

P.O. TYPE

3000

This latching device enables the P.O. 3000 type relay to be held in the closed position when the coil is de-energised and until manually released.

Does not impair the versatility of the contact arrangements, nor affect the normal mounting position.

Illustrations show 3000 Type Relay fitted with "Remote" & "Local" release latch.

●

WILL TRIP AND HOLD ON A.C. OR D.C. IMPULSE

●

EITHER TYPE CAN BE FITTED TO YOUR EXISTING 3000 TYPE RELAYS IN A MATTER OF MINUTES

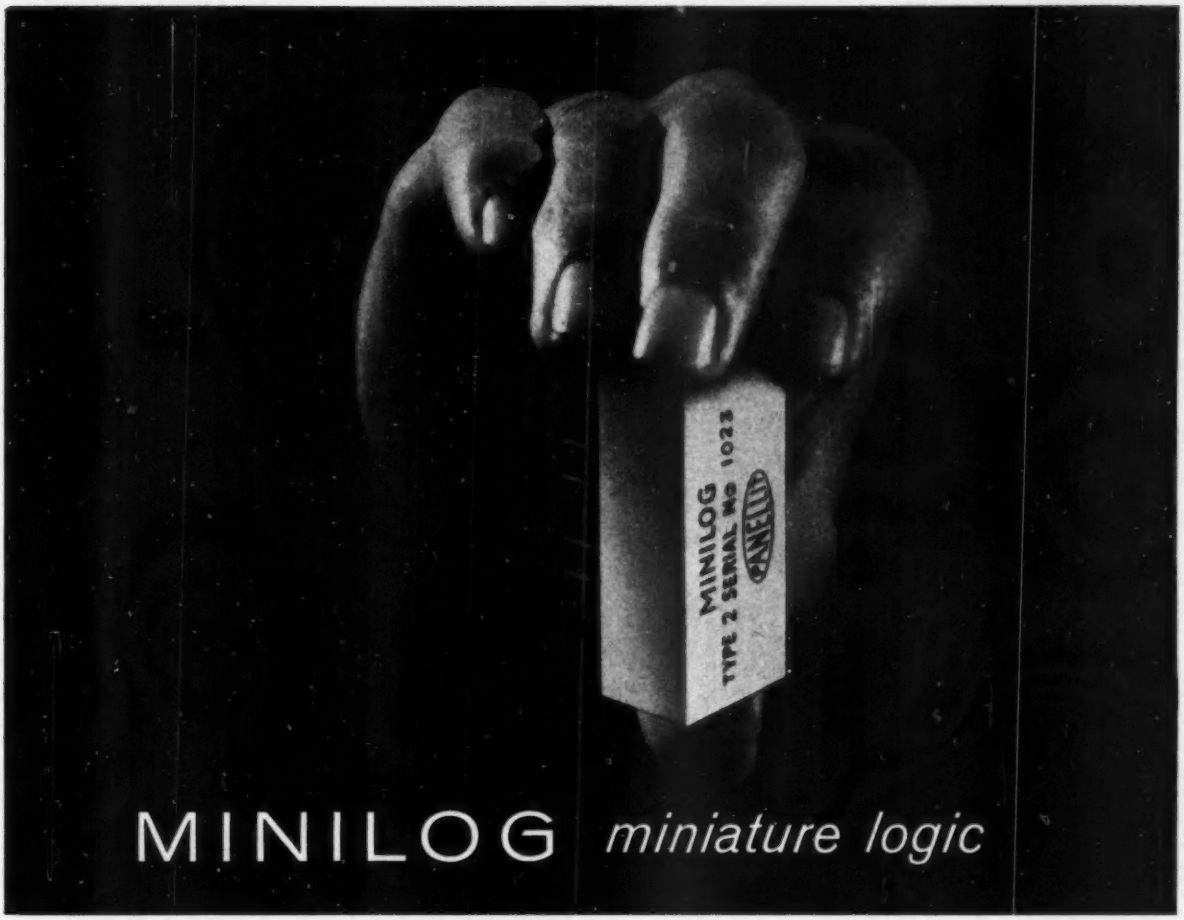
Please send for illustrated leaflet.

Jack Davis (Relays) Ltd.

(DEPT. E.) TUDOR PLACE, LONDON, W.1

TELEPHONES: MUSEUM 7960 LANGHAM 4821

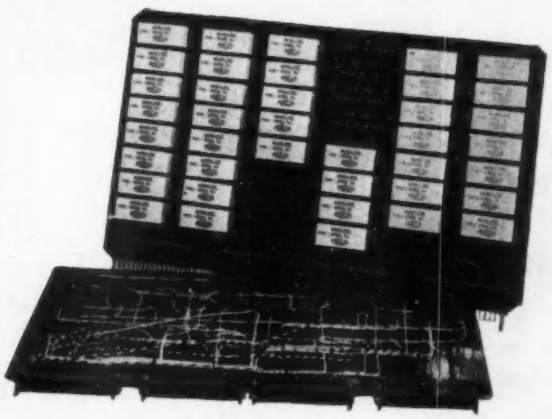
EE 30 205 *for further details*



MINILOG MKII: Panellit's new, improved TRANSISTORISED, MINIATURISED, ENCAPSULATED "building block" logic at lower cost and quicker delivery.

Every engineering designer should know about Minilog MkII, used exclusively in Elliott Computers, Controllers, Data Processors, Optimisers, etc. *It is now accessible to all engaged in the design of systems and equipment involving a logical function.*

One basic element provides a speedy, reliable method of designing and producing logical function devices. Power elements are available for process control power drive. *Development effort is reduced to logical system design on paper.* This can be translated directly and confidently into functional equipment.



Write or telephone for detailed information on this "new concept" logic building block, designed and used by the leading company in the field of automation.

PANELLIT

PANELLIT LIMITED

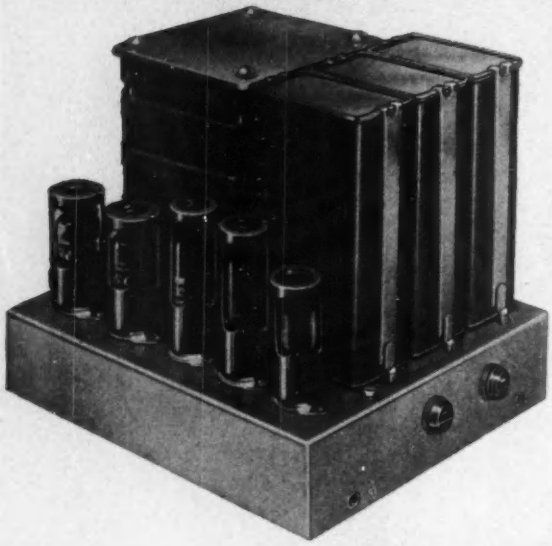
Elstree Way, Borehamwood, Herts. Elstree 2040

EA *A member of the Elliott-Automation Group*

PB

EE 30 207 *for further details*

STABILISED D.C. POWER SUPPLY UNITS



Chokeless, Open-Chassis Type. Paper Capacitors

D.C. OUTPUT:	Four sizes available, 100 mA output ±150v, ±200v, ±250v, ±300v, pre-set by an adjustable internal potentiometer.
STABILITY:	With mains variation ±10%, <0.06%.
RIPPLE:	<2mV R.M.S.
A.C. OUTPUT:	2x6.3v 3A centre tapped unstabilised.
INPUT:	200/250v in 10v steps 50/60 c.p.s.
TRANSFORMER:	Open type "C" core to R.C.S. 214 by FRASER SPELLER TRANSFORMERS LTD.
DIMENSIONS:	7⅛" x 6⅞" x 6¾" high.

Non standard voltages can be supplied if required.
Prices are extremely competitive and special discounts are offered for quantities.
Write for detailed List No. 1452 which will be posted by return.

FRASER, SPELLER TRANSFORMERS LIMITED
Electronics Division, Sydenham Road, Sydenham, London, S.E.26.

TRANSISTOR AMPLIFIERS
Designed and Manufactured
to meet your special requirements

V. Tessier LTD.
Tel HOUnslow 1331
95 STAINES ROAD, HOUNSLOW, MIDDX

EE 30 209 *for further details*

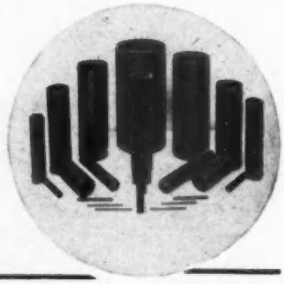
EE 30 208 *for further details*

ENALON PLASTICS LIMITED

Phone: TONBRIDGE 3343/4/5 **DRAYTON ROAD • TONBRIDGE • KENT** *Grams: 'ENALSCO'*

Specialist Manufacturers of Plastic Materials to the Electrical, Radio and Television Industries . . .

ENALON PRECISION WOUND COIL FORMERS
ENALON INJECTION MOULDING
ENALON S.R.B.P TUBING
ENALON STAMPINGS AND MACHINING

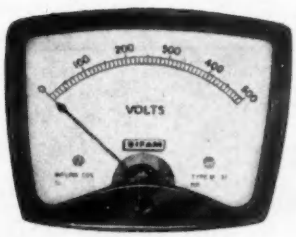


EE 30 210 *for further details*

To keep pace with the constantly increasing demand for one of this country's most comprehensive range of precision electrical measuring instruments, the new Sifam factory is now fully operative. Consolidating the resources of two previous plants, this new development, occupying 21,000 square feet, brings together under one roof machine shops, plastic moulding, tool rooms, plating and spray shops.

The new plant is purpose-built specifically for electrical measuring instrument development and manufacture. It is geared to ensure maintenance of high standards of service and product and special attention has been paid to new techniques in air-conditioning, dust-free assembly areas and internal communications.

a new factory... and a new range of instruments...



The new Wessex instruments provide a range of notable distinction and clean design. Illustrated are Types 21, 31 and 41.

Sifam

Instrumentation

... skilled craftsmanship and a thirty year old Tradition of Excellence ...

Write for full Catalogue information on the newest Sifam Developments.

SIFAM ELECTRICAL INSTRUMENT CO., LTD.,
Woodland Road, Torquay, Devon.
Torquay 63822/3/4
Telegrams: SIFAM, TORQUAY

EE 30 212 *for further details*

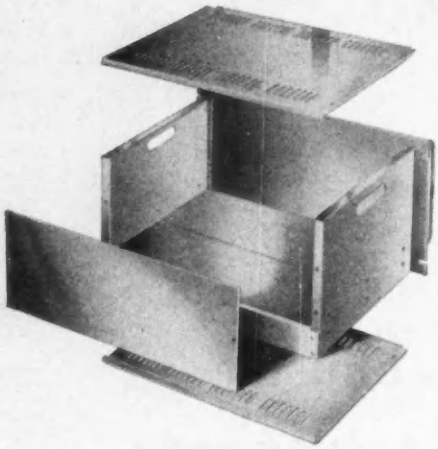
SECTIONAL CHASSIS UNITS

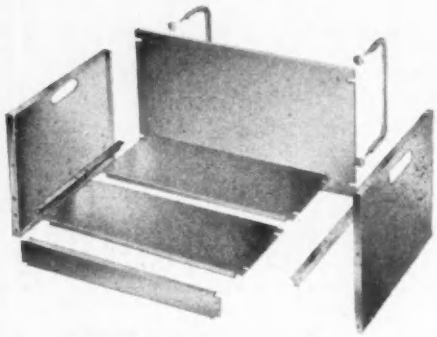
by Datum

* Available in a full range of sizes.

* Choice of aluminium or mild steel.

* Components include Panels, Handles and Protection Covers.





Datum

INSTRUMENT RACKS · CASES
CONSOLES AND CHASSIS UNITS

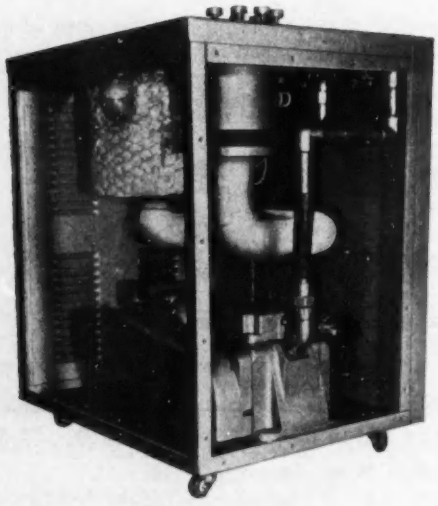
DATUM METAL PRODUCTS LTD.

A member of JLT GROUP

COLNE WAY TRADING ESTATE · WATFORD-BY-PASS · WATFORD · HERTS
Telephone: Watford 22351 Telegrams: Datum, Watford

RESIN IMPREGNATION

of wire-wound components under vacuum



N.G.N. new 'Resin-impregnating Plant' not only ensures better and far more thorough impregnation of all types of wire coils—its faster cycle of operation, coupled with carefully designed thermostatic control of vessels and pipework, plus full bore resin transfer valve, all combine to speed output while reducing costs.

Work chamber is evacuated to 1 micron Hg. to degas and dehydrate components which are then impregnated under a pressure of 80 lbs. p.s.i.

Surplus impregnant is completely recovered. Absolute reliability, both as regards thoroughness of impregnation and regular output is assured.

Enquiries for special plant to user requirements are especially welcome.

N.G.N. ELECTRICAL LIMITED
AVENUE PARADE, ACCRINGTON, LANCS. Tel: Accrington 35611-2

EE 30 213 *for further details*

GD537

Europe's most complete range of electro-mechanical VIBRATION GENERATORS

2lb. to 18,000lb. thrust force

Environmental testing at each stage of development–simulating the severest field conditions of vibration–gives modern components and equipment 'built-in' mechanical and functional reliability.

GOODMANS
Vibration Exciters and Oscillator Power Amplifiers provide the means for this analytical approach.

Whatever the problem . . whether fatigue, torsional or structural investigation . . consult

GOODMANS
the vibration specialists

Accredited Agents: HAWNT & CO. BIRMINGHAM
FARNELL INSTRUMENTS LTD., WETHERBY, YORKS.
JOHN BOLTON & CO. EDINBURGH

GOODMANS INDUSTRIES LTD, AXIOM WORKS, WEMBLEY, MIDDLESEX, ENGLAND · Wembley 1200 (8 lines) · Cables: Goodaxiom, Wembley, England

EE 30 215 *for further details*

LONDEX

RELAYS

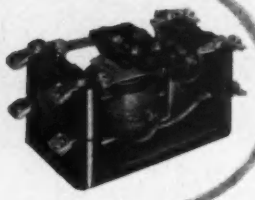
in thousands of variations

SMQ

A miniature mercury switch relay. Rating up to 20A. S.P.D.T. Coils up to 110v D.C. or 250v A.C.

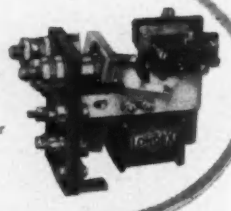
MOL

A small relay with moulded base and insulators. Contacts up to 3 amps. T.P.D.T. Coils up to 165v D.C. or 450v A.C.



LF/STR

A heavy current contactor for low voltage switching. Rating up to 100A at 24v. S.P.S.T. Coils up to 250v D.C. or 600v A.C.



For emergencies and breakdowns we can supply many types of relays with 200-250 V A.C. coils from stock.

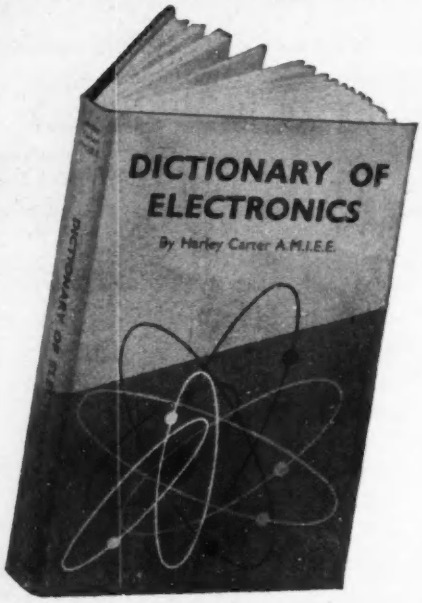
LONDEX LTD.

ANERLEY WORKS, LONDON, S.E.20
Telephone: SYDenham 3111

TA 2448

EE 30 216 *for further details*

An indispensable desk reference-volume for engineers, technicians and executives, apprentices and students in any way connected with electronics . . . .



384 pages with extensive cross-indexing

•

232 line drawings and circuit diagrams

•

Just published

DICTIONARY OF ELECTRONICS

by Harley Carter, A.M.I.E.E

THE field-of electronics has widened to such an extent that, with the new terms introduced with specific branches of the subject, the student and even the scientist find it difficult to keep up with new developments. Many engineers trained in alternative fields of technology are nowadays having to apply their knowledge to electronic equipment. It is with these points in mind that this illustrated dictionary is presented.

Priority has been given to the inclusion of fundamental facts and terms, and the other entries to a large extent follow on from these. Also listed are familiar terms and descriptions of many electronic instruments. Much supplementary material is given as an Appendix, including circuit symbols, abbreviations, colour codes, conversion tables and valve bases.

The concise but explanatory definitions from many branches of electronics, including radio, television, communications, radar, electronic instrumentation and industrial electronics, should prove of use to engineers, students, technicians, apprentices and to all those whose work or interest requires them to understand modern electronic terminology.

plus sections on . . .

Units and Abbreviations; Greek letters used in electronics; list of symbols; graphical symbols; colour codes for components; decibel conversion tables; the electro magnetic spectrum; frequency-wavelength conversion; valve bases; rationalized M.K.S. Units.

35s. net FROM ALL BOOKSELLERS . . . *or, in case of difficulty use this handy C.O.D. Order Form*

ORDER NOW

Please send me Cash on Delivery one copy of
DICTIONARY OF ELECTRONICS (35s. net)

Name.....

Address.....

NOTE—Send no money now—simply complete and post this order form TODAY to GEORGE NEWNES LTD., Tower House, Southampton Street, London, W.C.2. You pay on delivery plus normal C.O.D. charges. (If you prefer not to pay charges send a remittance for 36s. 3d.)

We grew up in a field of PRECIOUS METALS

Entering our third century, we can rightly claim to know an awful lot about this precious industry of ours. "Resting on our Laurels", however, is not for us—we prefer to think of laurels as repeat orders . . . our repeat orders have come by the hard way—by the continuous service we have maintained through two whole centuries to the Precious Metal Industry—and that is a long time . . . If you can use our experience, skill, and service, for silver solders, brazing alloys, electrical contacts and contact materials, or precious metals in any form, give us a call—you'll find we are 'old hands at the game'.

The **SHEFFIELD SMELTING**
COMPANY LIMITED

HEAD OFFICE AND WORKS: ROYDS MILL STREET, SHEFFIELD, 4.
ALSO AT LONDON AND BIRMINGHAM.

EE 30 218 *for further details*

VITREOSIL
PURE FUSED SILICA

VITREOSIL
TUBES AND SHEATHS

Electric furnace construction is one of the many applications of these tubes which, when wound with resistance wire, make a simple and inexpensive furnace. Equipped with an inner Vitreosil tube, such furnaces are very useful for combustion and other analytical work. These tubes, supplied in sand-surface or glazed finish, are eminently suitable for temperatures up to 1050°C. Fused silica has the lowest coefficient of expansion of any manufactured material, and is most resistant to thermal shock.

We also manufacture an extensive range Vitreosil Laboratory Ware

T S L

THE THERMAL SYNDICATE LTD.
P.O. Box No.6, WALLSEND, NORTHUMBERLAND. Tel.: Wallsend 62-3242/3
LONDON: 9, BERKELEY STREET, W.1. HYDe Park 1711/2

IMPROVED CRINKLE SPRING WASHERS in BERYLLIUM COPPER

Size Range 10 B.A. to ¼" B.S.F.

Satisfactorily meets the following requirements: Corrosion Resistance, Non-Magnetic, Excellent Electrical Conductivity, High Tensile Strength up to 85 tons per sq. in., Prevents damage to surfaces to be locked together. Made to Admiralty Signal and Radar Establishment Spec. A.110000–Approved by RAE/RSP. 318 & RCL. 224.

Supplied G.C.Q., A.I.D. or A.R.B. Released.

Prices and Samples on request.

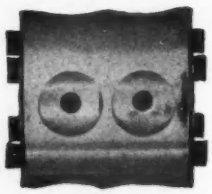
FORMERLY MARKETED BY DAVID POWIS & SONS LTD

THOMAS HADDON & STOKES LTD · DERITEND · BIRMINGHAM 12

EE 30 219 *for further details*

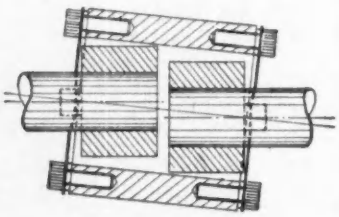
This Metastream ES Coupling

(illustration approx. actual size)



'FULFILS A LONG FELT WANT'

Says J. E. Hawkins of SOLARTRON



For servo motors and similar control drives, at last a miniature flexible coupling that is torsionally rigid and completely reliable. It's all metallic, with a diameter of only one inch. If this new ES Coupling is of interest to you, please send for literature and details.

METADUCTS LIMITED

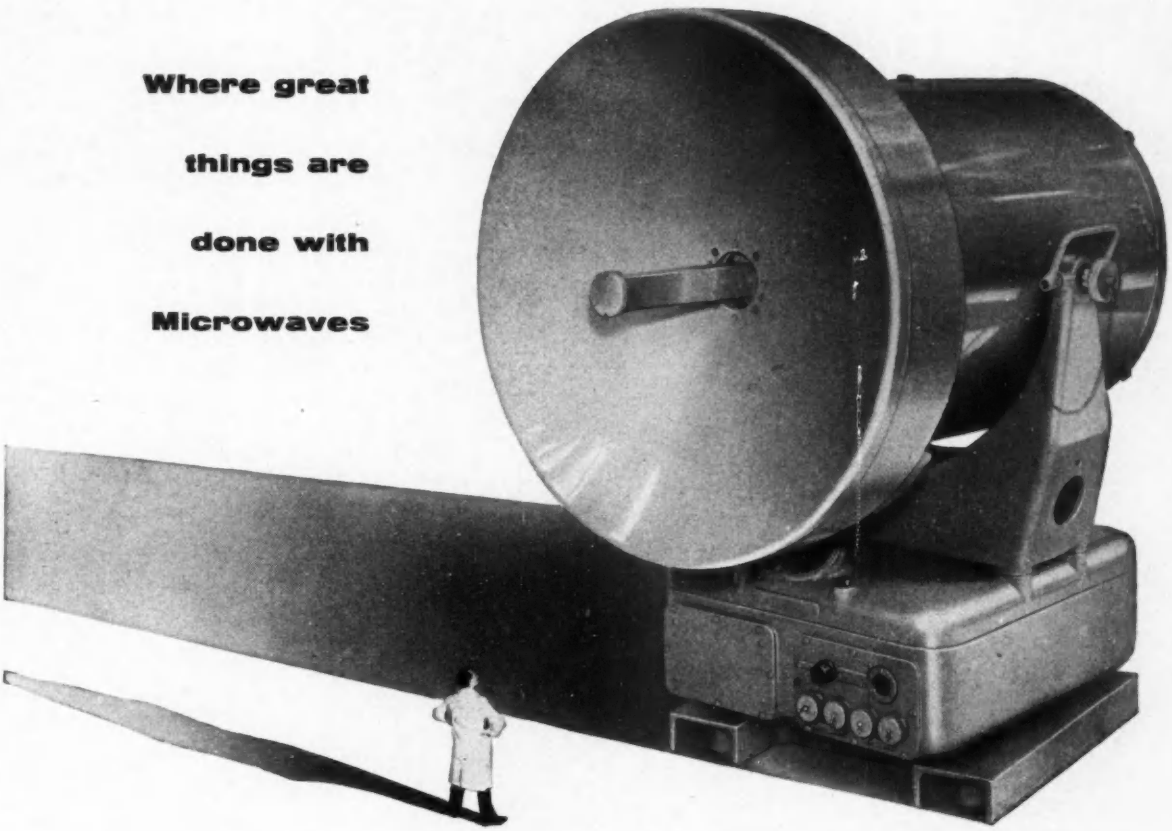
A member of the CONCENTRIC group of companies.

CATHERINE WHEEL ROAD, BRENTFORD, MIDDLESEX
Tel. ISLEWORTH 6441.

EE 30 220 *for further details*

EE 30 221 *for further details*

Where great things are done with Microwaves



RADAR: Fire Control · Navigation of Aircraft and Small Ships · Automatic Landing · Missile Guidance · Transponders • **COMMUNICATIONS:** Multichannel Radio Links for telemetering Data and Speech • **VALVES:** Klystrons and Magnetrons for 35 Gc/s and 75 Gc/s bands · Monitor Diodes for 1 Gc/s to 35 Gc/s • **INSTRUMENTS:** Comprehensive Waveguide measuring circuits covering 6 to 75 Gc/s • **RESEARCH:** Outstanding Research and Development of the latest techniques.

ELLIOTT

COMMUNICATIONS DIVISION · RADAR DIVISION · VALVE DIVISION
MICROWAVE & ELECTRONIC INSTRUMENTS DIVISION · RADAR RESEARCH LABORATORY

ELLIOTT BROTHERS (LONDON) LTD

Elstree Way, Borehamwood, Hertfordshire · Elstree 2040
Airport Works, Rochester, Kent · Chatham 4/4400

A MEMBER OF THE ELLIOTT-AUTOMATION GROUP

RG1

EE 30 222 *for further details*

WHY PICK ON US?

(. . . a question with many answers)

BECAUSE WE'RE FRANK ABOUT DELIVERY.

You get an honest answer to your enquiry and you get it promptly. Right now, we are very busy, but that does not mean that we cannot take on your work. We suggest that you give us a chance . . . and you can be sure that whatever delivery promise we make will be kept. For fuller details of this unique service please contact Leslie D. Izzard, Planning Director.

BROXLEA SERVICE

ELECTRONIC MANUFACTURE, ASSEMBLY, WIRING, ETC.

View of the Broxlea Works—14,500 sq. ft. of ultra modern factory space, 15 miles from central London on the A10 road to Cambridge.

Trusted by the people you trust

Below are some famous names —firms who entrust work to Broxlea:—

Associated Electrical Industries Ltd.
Bell Punch Co. Ltd.
Bristol Aircraft Ltd.
E. K. Cole Ltd.
Cossor Radar & Electronics Ltd.
Dewhurst & Partner Ltd.
Elliott Bros. (London) Ltd.
E.M.I. Electronics Ltd.
Enfield-Standard Power Cables Ltd.
English Electric Aviation Ltd.
Eversheds & Vignoles Ltd.
General Electric Co. Ltd.
General Precision Systems Ltd.—Air Trainers Link Division
Ilford Ltd.
International Computers and Tabulators Ltd.
Marconi's Wireless Telegraph Co. Ltd.
Microcell Ltd.
The National Cash Register Co. Ltd.
Pye Ltd.
A. V. Roe & Co. Ltd.
Standard Telephones & Cables Ltd.
Telephone Manufacturing Co. Ltd.
Texas Instruments Limited
Tube Investments (Group Services) Ltd.
Witton-James Ltd.

you will be in good company if you, too, trust Broxlea.

BROXLEA PRODUCTS LIMITED (A.I.D. approved)
BROXBOURNE, HERTS **Hoddesdon 4455**

EE 30 223 *for further details*

APM

small capacity
Injection Moulding Machines

The APM Company are specialists in the field of small capacity thermoplastic moulding machines for experimental work, small production runs, Educational and Laboratory work and small component mouldings.

Our new range of machines include:—

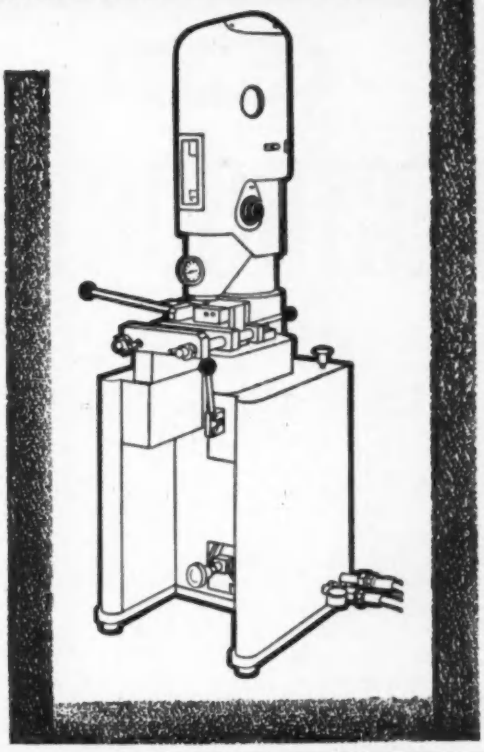
APM 22—redesigned ¾ oz capacity, hand-operated machine with interchangeable cylinders and a selection of vices.

APM 28—New 1 oz capacity hydraulically operated machine capable of 200 shots per hour at pressures up to 20,000 lb/sq. in.

ADAPTER UNITS—Pneumatic or hydraulic adapter units to convert the APM 22 and APM 21 machines to power operation.

For literature and prices write to:

ASMIDAR PLASTIC MOULDING MACHINES LIMITED,
10 Tachbrook Street, London, S.W.1. Tel: VICtoria 5554



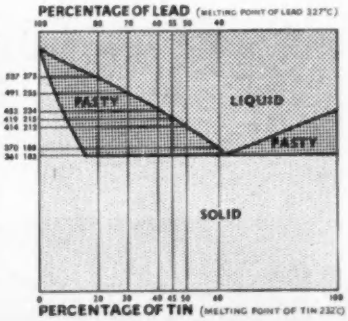
There is a
MULTICORE SOLDER
for every application

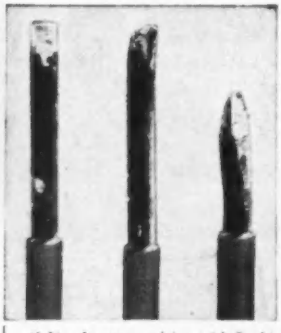
ERSIN MULTICORE 5-CORE SOLDER

The A.I.D. approved type 362 flux, incorporated in Ersin Multicore 5-Core Solder, is very effective on heavily oxidised surfaces and often allows the use of a lower tin content alloy. Ersin Multicore 5-Core Solder is supplied on 7 lb. reels in 9 standard gauges and 6 alloys. Even gauges from 24-34 s.w.g. are available in 2 alloys on 1 lb. and ¼ lb. reels.

CONSTITUTION OF ALLOYS OF ERSIN MULTICORE SOLDER

The diagram shows that all the standard alloys of Ersin Multicore Solder have a plastic range, i.e., on heating they are pasty between the solid and liquid states. Practical experience has shown that there are advantages in having a plastic range, e.g. for tag jointing where the use of 60/40 alloy obviates fractures which may occur with other alloys where there is slight vibration while the solder is setting solid.

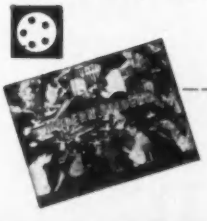

PERCENTAGE OF LEAD (MELTING POINT OF LEAD 327°C)
100 90 70 60 55 50 40
PASTY
LIQUID
PASTY
SOLID
0 10 30 40 45 50 60 100
PERCENTAGE OF TIN (MELTING POINT OF TIN 232°C)



(left) after 10,000 joints with Savbit. (centre & right) after 1,000 and 7,500 joints respectively with standard tin/lead alloy.

PRINTED CIRCUITS

Leaflet P.C.L. 101 gives full details of a complete soldering process developed by Multicore Laboratories for printed circuits.



SAVBIT TYPE 1 ALLOY

Made under sole British Licence of Patent No. 721,881.

Savbit Type 1 alloy was developed after extensive research in the Multicore Laboratories into the main causes of bit wear. It incorporates a small percentage of copper which prevents absorption of copper from the bit into the solder alloy. After prolonged tests, it was found that the life of solder bits was increased by up to 10 times. The speed of soldering is not affected.

SPECIAL ALLOYS

4 special alloys can be supplied for particular purposes:

Comsol with a high melting point of 296°C.

T.L.C. alloy with a melting point of 145°C is made from tin, lead and cadmium.

P.T. (Pure Tin) alloy, with a melting point of 232°C, is lead-free.

L.M.P. alloy, with 2% silver content, which melts at 179°C for silver-coated components.

PUBLICATIONS

Laboratory engineers and technicians are invited to write on their company's letter-heading for the latest edition of Modern Solders. It contains data on melting points, gauges, alloys, etc.

MULTICORE SOLDERS LIMITED, MULTICORE WORKS, HEMEL HEMPSTEAD, HERTFORDSHIRE
TEL: BOXMOOR 3636 (4 LINES) GRAMS AND CABLES: MULTICORE HEMPSTEAD

TA 4902

EE 30 224 *for further details*

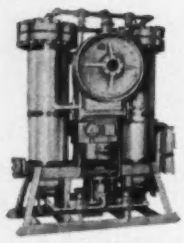
30 225 for further details

NOW THE GWB LECTRODRYER

a complete range of air drying equipment

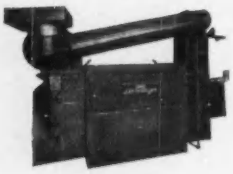
Lectrodryers give you absolute control of moisture. A complete range of equipment is offered: for atmospheric or high-pressure conditions, for very small or very large volumes, for air, gases and certain organic liquids. Also available are standard dehumidifier units for air conditioning.

The basic element of a Lectrodryer is an adsorber unit, which is reactivated by heat to maintain constant high efficiency. Lectrodryers intended for continuous operation have multiple adsorbers, the flow being switched to allow reactivation. Such units can be equipped for manual or completely automatic control.



Air dryer as used in high pressure compressed air installations—600 lb./sq. in.

Dual-adsorber Budget Air Dryer, used where extremely dry air is required in small volumes up to 20 c.f.m. This unit weighs only 68 pounds.



An air conditioning dryer of the type used in such plants as sweet factories.

Latest design of fully automatic instrument air dryer.

GWB

G.W.B. FURNACES LTD. DIBDALE WORKS, DUDLEY, WORCS

GWB244

EE 30 226 for further details

Wilkinsons

EST. 1921

FOR METERS GUARANTEED

NEW RANGE OF METERS

2½" Moving Coil Flush Round
0/1 amp; 0/3 amp; 0/5 amp; 0/10 amp; 0/20 Volts; 0/30 Volts; 0/40 Volts; all at 35/- each.

2" Moving Coil Flush Round
0/1 Milliamp; 0/5 Milliamp; 0/10 Milliamp; 0/20 Volts; 0/30 Volts; 0/40 Volts; all at 27/6 each.

2" Moving Coil Flush Square
0/3 Ampere; 0/5 Ampere; both at 27/6 each.

RELAYS

Post Office Type 3000
Made to your specification.
Contacts up to 8 C.O.

Prompt Delivery

MINIATURE RELAYS IN STOCK

Siemens High Speed Sealed and S.T.C. & G.E.C. Sealed.

RACKS—POST OFFICE STANDARD. 6 ft. high with U-channel sides drilled for 19 in. panels, heavy angle base, 4 ft. 10 in. also in stock.

RESISTORS EX STOCK, IN QUANTITY WIRE WOUND, HIGH STABILITY CARBON ETC., BEST MAKES AT LOWEST PRICES

¼ H.P. CAPACITOR MOTORS, 230/240, 50 cycles, 1,420 r.p.m., ⅜ in. shaft, resilient mounting or ½ in. shaft, foot mounting, **£5 10s.,** carriage 10/-.
VACUUM PUMP & COMPRESSOR, Edwards Type IV, ¼ in. shaft, complete with flywheel, couplings, oil, filter and union. **£6 10s.,** post 3/6.
SOLENOIDS suitable for remote control, mechanical indicators, etc. 12v d.c., 400 M.A. 3½ in. arm, ½ in. movement. 5/- each net.
AMMETER, 0-3 amp d.c., Turner Model 32, MC/FR, 6 in. dial, **90/-.**
PORTABLE AMMETER, 0-3 amp a.c./d.c., 3 in. In case, **35/-.**

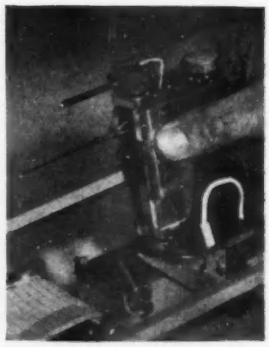
L. WILKINSON (CROYDON) LTD.
19 LANSDOWNE RD. CROYDON SURREY
Phone: CRO 0839 Grams: WILCO CROYDON

SEFRAM PARIS

RAPIDGRAPH

Portable HIGH SPEED Pen Recorders

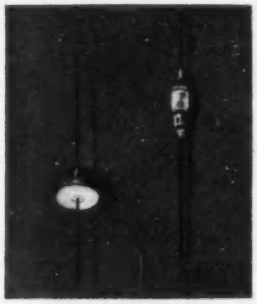
With interchangeable pen units of different natural frequencies. Very low power required e.g. 15mW at 15 c/s. This often saves the use of amplifiers and their power supplies. Linearity in amplitude within 1%. The Rapidgraph can be used in moving vehicles as the stiffness of suspension makes it insensitive to acceleration and external vibration.

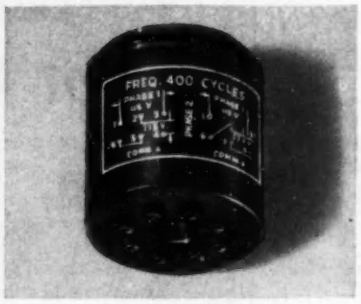


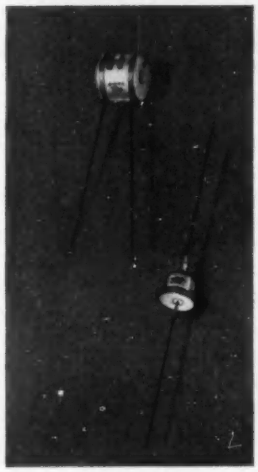
Available with or without paper rewind; bench or rack mounting 1, 2 or 5 channels.

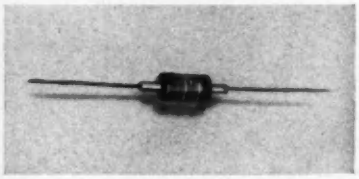
Dobbie McInnes
(ELECTRONICS) LTD
55, Kelvin Ave., Hillington, Glasgow. Halfway 3364
4, The Mount, Guildford, Surrey. Guildford 66385

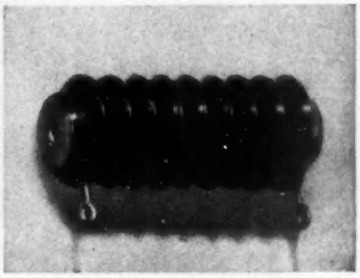
EE 30 227 for further details











NOW...

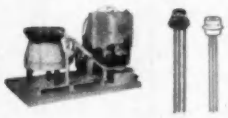
MARK THEM AS FAST AS YOU MAKE THEM

with clear, durable, attractive imprints

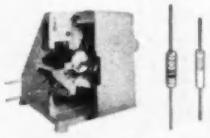
Here's how typical marking needs are met by Markem

Model 148A — Completely Automatic Marking of all types of surfaces — flat, curved, corrugated, irregular, etc. — without hand rolling or pressing. May be mounted for automatic in-line marking or objects may be hand fed to adjustable work table. Average production 2100 to 3100 per hour.

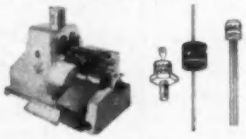
Model 122A — Simultaneous Top and Side Marking as well as date coding of transistors, similar cylindrical components with base leads. Hopper-fed machine automatically prints and ejects up to 2500 units per hour.



Model 69A — High Speed Color Banding of diodes, resistors, capacitors, similar axial lead cylindrical components. Up to 6 colors simultaneously, or 5 color bands plus typographical marking. Color, band width, spacing easily changed.



Model PAF-AG — Versatility for marking components with axial, one-end axial and radial leads, and components without leads. Production to 3000 per hour. Offset printing unit eliminates rubber plates, and use of Masterplates permits quick changes of all or part of the imprint.



Helping your product speak for itself

A Markem machine can mark your electrical or electronic product *at production speeds*, even when imprint changes are frequent. More than 40 basic groups of machines have been developed to mark all types of parts and packages using one of the thousands of specialty inks that have been formulated for marking metals, plastics, glass and other materials. We can supply inks for air drying, baking or firing and with resistance to handling, high temperatures, salt spray, humidity and other environmental conditions. With 49 years of experience in the industrial marking field, Markem now offers the world's most complete line of machines, type, ink and supplies — plus helpful advice and service from competent representatives.

Write for this 12-page catalog of Markem machines and related equipment for the electrical and electronics industries. Complete specification sheets are also available for individual machines.

MARKEM (U. K.) LIMITED
24 Brownfields
Welwyn Garden City, Herts, England

MACHINEHANDEL H. RUSCHE
Via Maartensdijk
Hollandsche Rading, Holland

EE 30 229 *for further details*

wherever speed frequency or voltage is controlled you'll find Sanders

TRANSDUCTOR AND MAGNETIC AMPLIFIER SYSTEMS

Type 1000

Encapsulated transductors for Climatic Classification 40/70 HI. Inter-Service Type Approved as specified in R.C.S. (Prov) 217

Supply Freq.	*D.C. Output*
50 c/s	From 0·005W to 11W
400 c/s	From 1W to 145W

Type 2000

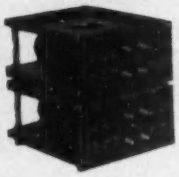
Open-type transductors for Climatic Classification 40/70 H2. Used in steel works, coal mines and similar situations demanding robustness and reliability.

Supply Freq.	*D.C. Output*
50 c/s	From 50W to 500W
400 c/s	From 500W to 4000W

Type 3000

Toroidal core transductors encapsulated in any epoxy-resin to meet Climatic Classification 40/70 HI. Admiralty approved; used extensively in Service equipment.

Supply Freq.	*D.C. Output*
50 c/s	From 50W to 250W
400 c/s	From 500W to 2000W



Type 4000

The construction of these transductors is such that they can be supplied as either 1, 2, or 3 element assemblies. Climatic Classification 40/70 H2.

Supply Freq.	*D.C. Output*
50 c/s	From 50W to 1000W
400 c/s	From 500W to 8000W

The Sanders range of high performance transductors is ideally suitable for use in automatic control systems and applications where size, weight and quality are important. A comprehensive selection exists for operation from both 50 c/s and 400 c/s supplies. In addition a large selection is produced with windings to suit individual requirements.

This is one of a series of new instruments and components by

THE Sanders GROUP OF COMPANIES

W. H. SANDERS (ELECTRONICS) LTD

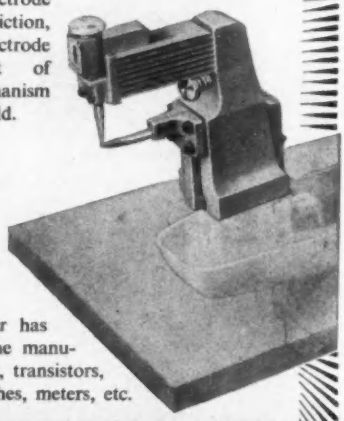
GUNNELS WOOD ROAD STEVENAGE · HERTS
Telephone: Stevenage 961. Telex 82159 Sanders Stev.

EE 30 230 *for further details*

SPOT WELDING

UNIT TYPE 'BH'

DISTINCTIVE FEATURES: Capable of highest welding speeds e.g. 1 millisecond weld pulse. Moving electrode system free from play or backlash. Electrode movement at instant of weld truly linear. No mechanical variants in moving electrode system due to friction, etc. Moving electrode is independent of operating mechanism at instant of weld.



HED

The 'BH' welder has many uses in the manufacture of valves, transistors, resistances, watches, meters, etc.

HIRST ELECTRONIC LTD.
GATWICK ROAD, CRAWLEY, SUSSEX

ALWAYS USE Grip

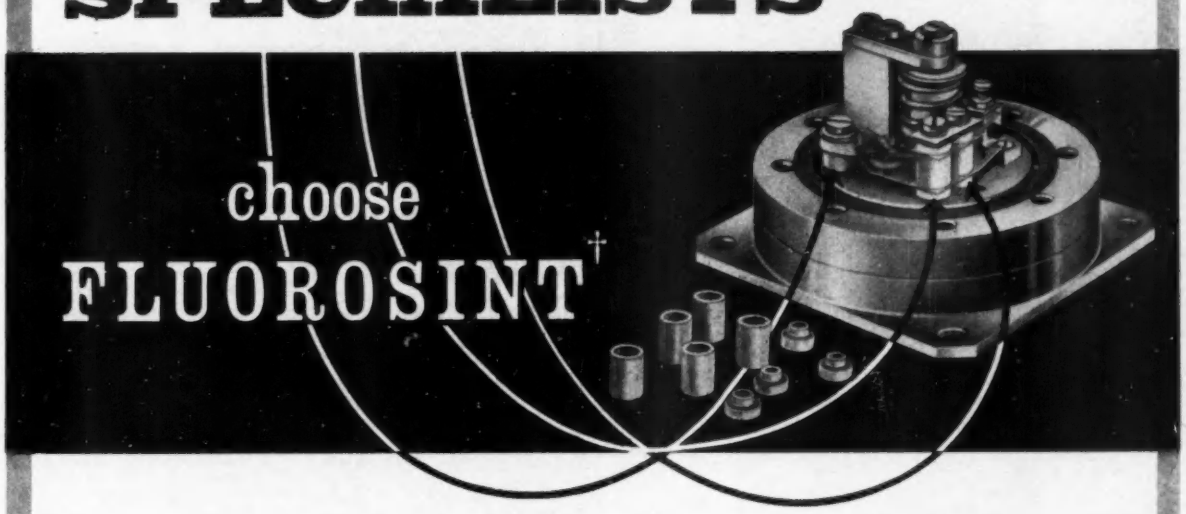
Drill & Reamer Jig Bushes.

Manufacturers of the complete range of jig bushes and liners to B.S.S. 1098/1953, together with special purpose bushes for sheet metals, plastics, and moulded jigs.
Catalogues sent upon request.

TALBOT TOOL COMPANY LTD.
GRIP WORKS · ROEDALE ROAD · BRIGHTON · SUSSEX
Telephone: BRIGHTON 55832
Telegrams: GRIPTOOLCO, BRIGHTON

EE 30 231 *for further details*

Absolute
PRESSURE SWITCH SPECIALISTS*



choose FLUOROSINT†

for HIGH TEMPERATURE STABILITY
LACK OF 'CREEP' · ZERO WATER ABSORPTION

† FLUOROSINT is a filled P.T.F.E. of unique plastic composition developed by Polypenco Ltd. to improve the mechanical and thermal properties of T.F.E. without materially affecting its excellent chemical and electrical characteristics. FLUOROSINT is machineable to close tolerances, has a water absorption rate of zero, a coefficient of thermal expansion similar to aluminium—thereby eliminating problems of fits and clearances of parts on thermal cycling. FLUOROSINT has exceptional wear characteristics, outstanding chemical resistance—and is available in Rod, Tube, Tape or as fabricated and moulded components. Complete technical data and information on all industrial applications are readily available on request.

* Clifford Edwards Ltd. of Hove, Sussex, incorporate support pillars, spacers and washers machined from FLUOROSINT Rod in the production of Absolute Pressure Switch, ref. TP.5658—designed primarily for aircraft fuel warning systems operating at very high altitudes. The pressure setting range is 1-50 p.s.i. absolute: temperature range −50°C to +100°C. The switch is evaluated to 1 mm. of mercury.

† FLUOROSINT is a trademark of Polypenco Ltd. and is a material produced by a patented process.

POLYPENCO

TRADE MARK

Write for further details to:

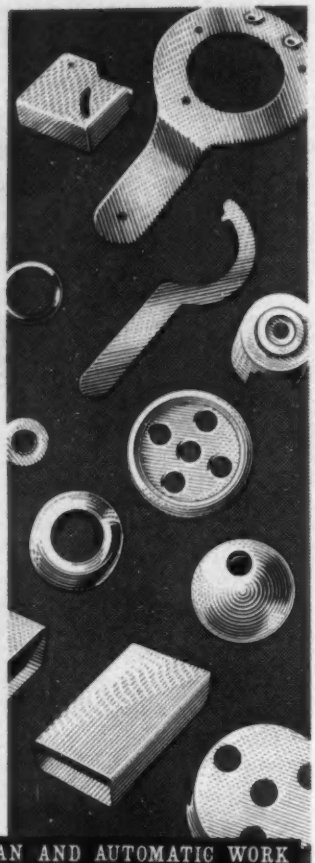
POLYPENCO LIMITED

68–70 Tewin Road,
Welwyn Garden City, Herts.
Telephone: Welwyn Garden 5581-3

NORTHERN OFFICE:
117 Swan Arcade, Bradford, Yorks.
Telephone: Bradford 32073

Associated Companies in U.S.A., France and Germany

EE 30 233 *for further details*



CAPSTAN AND AUTOMATIC WORK

SHEET METAL PRESSINGS

ANY METAL ANY FINISH

G·G·L

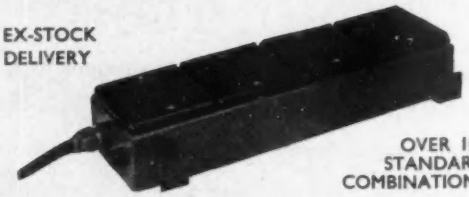
to be sure !

GRIFFITHS, GILBART, LLOYD & CO. LTD.
EMPIRE WORKS, PARK ROAD, BIRMINGHAM.

EE 30 234 *for further details*

THE LEXOR "DIS-BOARD"
For Power Extension and Expansion Everywhere

EX-STOCK DELIVERY



OVER 100 STANDARD COMBINATIONS

Full Literature and Price List from:—

LEXOR ELECTRONICS LIMITED
ALLESLEY OLD ROAD
COVENTRY

EE 30 235 *for further details*

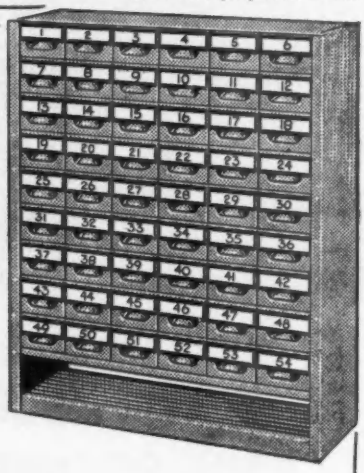
THE **"54"** DRAWER UNIT

ALL STEEL Stove Enamelled DARK GREEN

•

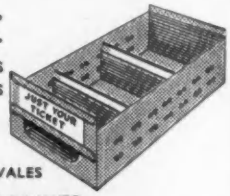
OVERALL SIZE 42" HIGH 35" WIDE 11¼" DEEP

•



Contains 54 of these drawers, each 5" wide 3" high 11¼" long.

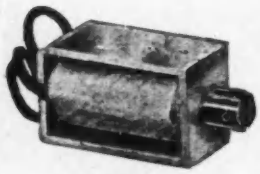
54 dividers and 54 drawer cards with each unit. Extra dividers 6d. each.



£18 DELIVERED FREE to ENGLAND, SCOTLAND and WALES

SEND FOR SAMPLE DRAWER

N. C. BROWN LTD.
EQUIPMENT WING . HEYWOOD . LANCS.
Telephone: Heywood 69018 (*6 lines*)



Quick Delivery—
Solenoids are normally despatched same day as receipt of order

PHIL-TROL SOLENOIDS

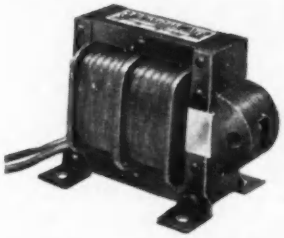
New 6 Page Leaflet (No. 108a) now available. Covers small and medium solid core types including new types 45, 35, 36 and 37

SEND FOR YOUR COPY NOW

PHILLIPS CONTROL (G.B.) LTD.
Dept. G7, Farnborough, HANTS. *Tel: Farnborough 1120*

EE 30 236 *for further details*

A. C. SOLENOID TYPE SBM



Now fitted with stainless steel guides—six times the life.

Continuous 3¾ lbs. at 1"

Instantaneous to 16 lbs.

Smaller sizes available

Also- Transformers to 7kVA 3 phase

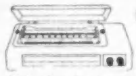
R. A. WEBBER LTD.

18 FOREST ROAD, KINGSWOOD, BRISTOL. PHONE 67-4065

PHOTOCOPYING

from periodicals and Books is the Contoura speciality

Only Contoura has the translucent air-cushion to give perfect contact over curved pages—maximum flexibility with moderate cost, e.g. Quarto £38, Foolscap £50 complete. Orthodox office machines also supplied and demonstrated.



ROTARY COMBINE

FLATBED

Write for details of equipment and ***photocopying service***

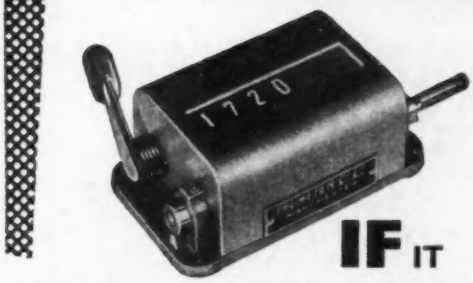
the simpler, quicker way to copy ANYTHING

contoura

Contoura Photocopying Limited

(Dept. EE) 52a Cromwell Rd., London, S.W.7. (KNI 8860)

EE 30 238 for further details



IF IT

ROTATES OR RECIPROCATES MECHANICALLY OR ELECTRICALLY

COUNT ON . . .

TRUMETER

COMPANY LIMITED

MILLTOWN ST., RADCLIFFE Nr. MANCHESTER

TELEPHONE: RADCLIFFE 2675

C.W. 5327.

WITHOUT FAIL

The Whole Year Through *for 36/-*

For this small sum "Electronic Engineering" will be delivered to you on the last Friday of every month for a year. Be sure of a regular supply of the industry's leading technical journal by filling in the coupon, and either handing it to your newsagent or sending it direct to:—

Electronic Engineering

28 ESSEX STREET, STRAND, LONDON, W.C.2

I enclose 36/- as a remittance for 12 issues of "Electronic Engineering".

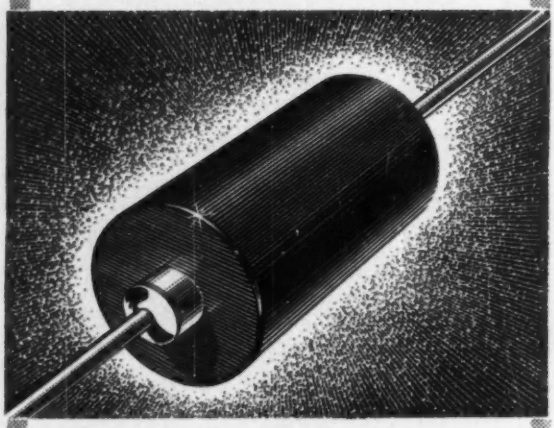
Name .....

Address .....

Signature.....

EE 30 240 for further details

ASHBURTON PRECISION WIREWOUND RESISTORS



ER — RANGE

These units are encapsulated with conventional resin which protects the wire during assembly operations. Working temperature range 0°C—100°C.
Range: 0.1 Ω—10MΩ Rating: ¼W—2W.

P RANGE — NYLON EMBEDDED

Nylon improves physical mechanical and electrical properties giving maximum possible seal against humidity over a temperature range of −50°C to +120°C.
Range: 10 Ω to 1.6MΩ. Rating: ¼W and ½W.

All units graded by colour in five standard tolerances 0.05%—1%.
DELIVERY: Two to three weeks from receipt of order.
For full technical details write or phone:—

ASHBURTON RESISTANCE CO. LTD.
72 Brewery Road, LONDON, N.7 Tel.: NOR 1168

ASHBURTON
PRECISION RESISTORS

Just out! the NEW STANELCO

- Perfectly balanced
- Flat copper bit shaped for any application
- New stainless steel side plates eliminate corrosion
- Strong robust element with large surface ensures good heat transfer and long life
- Improved shock resisting moulded handle.

100 WATT SOLDERING IRON
costs only **29/-**
including post and packing. Trade quantity discounts on request.

All elements flash tested at 1000 volts to earth to ensure RELIABILITY, QUALITY AND SAFETY

A really professional, high wattage iron at an economical price

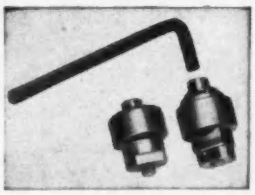
Suitable for operation at 12 v., 50v., 100/110 v., 200/220 v., and 230/250 v.

Please state voltage required when ordering.

Send for leaflet or order direct from:

Standard Telephones and Cables Limited
Industrial Supplies Division
Stanelco Process Heating, Footscray, Sidcup, Kent.
Footscray 3333

"Q-MAX" SHEET METAL PUNCHES



Patent No. 619178 and Patents pending.

Round, Square and Rectangular. The easiest and quickest way of punching holes in SHEET METAL.

LIST OF SIZES AND PRICES ON APPLICATION

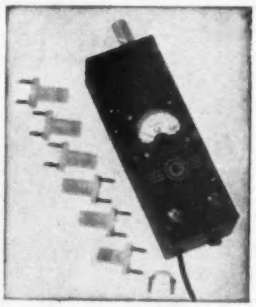
SOLE LONDON DISTRIBUTORS OF

ELCOM

MINIATURE MULTI-WAY PLUGS AND SOCKETS

A full range of connectors from 2 to 33 way, proven in use by the electronic industries of the world.

"Q-MAX" MODEL G.D.O.-2 GRID DIP OSCILLATOR



An ideal instrument for the determination of tuned circuit resonant frequency, tuning transmitters without application of power, for the determination of coil mutual and stray inductances and both fixed and stray capacitances. Covers 1.5 to 300 Mc/s in eight ranges. Built in mains pack.
PRICE 15 Gns. Complete.

Fully illustrated CATALOGUE available on request

BERRY'S RADIO
25 HIGH HOLBORN, LONDON, W.C.1
Tel.: HOLborn 6231/2

IMPORTANT NEWS

for designers of transistorised equipment

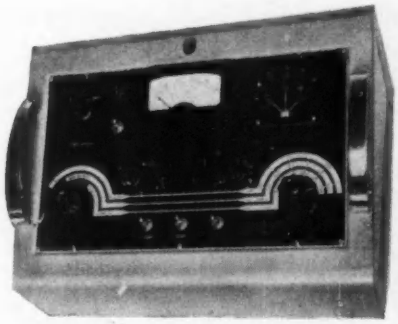
PHILIPS COMPACT

TRANSISTOR TESTER

The Philips PP2010 Transistor Tester combines in one instrument test facilities for practically every type of transistor generally available at the present time. Characteristics of both PNP and NPN transistors can be checked and their working parameters established *instantly*.

- **Base-collector short circuit gain (α').**
- **Collector current with zero base current (I'c (o)).**
- **Collector turnover voltage.**

Full technical details from Sole Distributors in the U.K.



SPECIFICATION

Current gain (α') Ranges 0-100, 0-200 } accuracy ± 7%
Collector voltage 0-30V
Collector current max. 0-1.5A
Leakage current (I'c(o)) 0-1.5A (Two ranges)
Collector voltage 0-30V
Collector turnover voltage Range 0-100V
Mains input 110-250V, 40 to 60c/s. Consumption approximately 15VA.

RESEARCH & CONTROL INSTRUMENTS LIMITED

INSTRUMENT HOUSE · 207 KING'S CROSS ROAD · LONDON W.C.1 · TEL: TERMINUS 2877

(RCL0445)

OFFICIAL

AVO

REPAIR SERVICE

All repairs guaranteed 12 months. QUICK SERVICE. Our Staff is fully trained by **AVO LTD.** Final tests and calibration carried out on **AVO** test equipment. Repairs sealed with the **AVO** seal—the mark of Perfection.

FARNELL INSTRUMENTS LIMITED
YORK ROAD WETHERBY *Tel: Wetherby 2691/2*

EE 30 245 *for further details*

YOU are invited to apply for a copy of our 1960 illustrated brochure and price list which gives full details of our wide range of

QUARTZ CRYSTAL UNITS

which are renowned for their

Accuracy & Reliability

THE QUARTZ CRYSTAL Company Ltd.
Q.C.C. Works, Wellington Crescent, New Malden, Surrey
Telephones: MALden 0334 & 2988 Grams & Cables: Quartzco, New Malden

EE 30 246 *for further details*

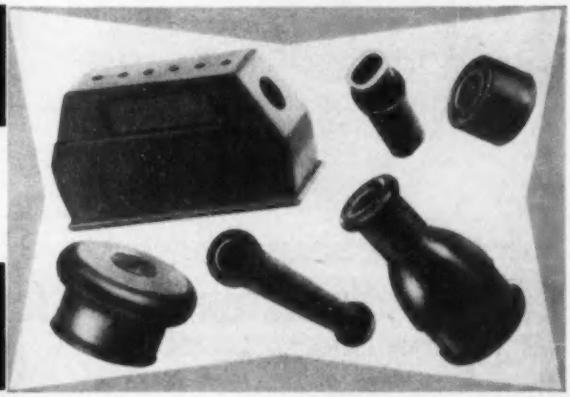
Specialisation plus 60 years experience *adds up to the*

Dainite Service

IN MOULDED RUBBERS

Our 60-plus years of specialised experience gives our technical representatives a unique advantage in advising on all problems concerned with the application and production of Rubber Mouldings. Fully approved A.I.D. and A.R.B.

THE HARBORO' RUBBER CO. LTD.
Dainite Mills, Market Harborough Tel: 2274/6



EE 30 247 *for further details*

Plan ahead with the
LINVAR SYSTEM OF CABINETS, RACKS, CASES, CHASSIS, TROLLEYS, DESKS, SPECIALS, etc.

★ PIECE PART SYSTEM
★ SCIENTIFIC COOLING
★ COMPACT STORAGE
★ MODERN STYLING
★ EX. STOCK DELIVERY

LINVAR LIMITED
BALFOUR ROAD, WEYBRIDGE, SURREY Telephone 6962

TRANSFORMERS

WE SPECIALISE IN THE MANUFACTURE OF TRANSFORMERS FOR THE ELECTRONIC AND ELECTRICAL INDUSTRIES

A.I.D. and ADMIRALTY approved

Your enquiries will receive our prompt attention

STEWART TRANSFORMERS LTD.
KILBURN LANE · LONDON W.10.
Tel.: LAD 2296/7

EE 30 249 *for further details*

VHF MOBILE AERIAL
TO YOUR SPECIFICATION

* Will fit standard aerial bases and supplied cut to your frequency requirements.
* Panorama Aerials are used by Police Forces, Fire Brigades and Ambulances.
* Flexible, yet robust, made of high tensile steel, copper or silver-plated. Plastic cover, corrosion proof.

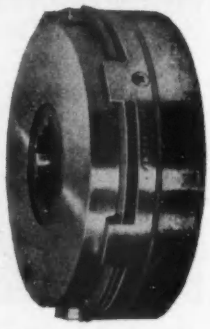
Please write for details to:—

PANORAMA
RADIO COMPANY
73 Wadham Road
London SW15

EE 24 250 *for further details*

WRIMAR ELECTRO-MAGNETIC CLUTCH BRAKE UNITS

A compact high power coupling . . . of low weight. Transmits high torque with low current consumption. Can be remotely controlled and is self-adjusting. Enables designers to develop new ideas for power transmission, resulting in more compact gearboxes for machine tools and more sensitive control of all purpose power drives.
Static Field Clutches and Brakes for Instrumentation. Spring-loaded, Electro-magnetically Released Disc Brakes. Electro-magnetically Controlled Gear-boxes.



Please send for full particulars
WRIGHT & MARVIN LTD.
BRISTOL ROAD, GLOUCESTER. 'Phone: 22837

EE 30 251 *for further details*

Wouldn't life be tedious?

Often at the end of a fabrication job in steel or light alloy we feel a surge of pride. Perhaps we have surveyed, designed, drawn up, made and assembled a complete installation. Or finished a quantity run of some intricate machined item. We can't always crow in public—but wouldn't life be dull without such highlights?

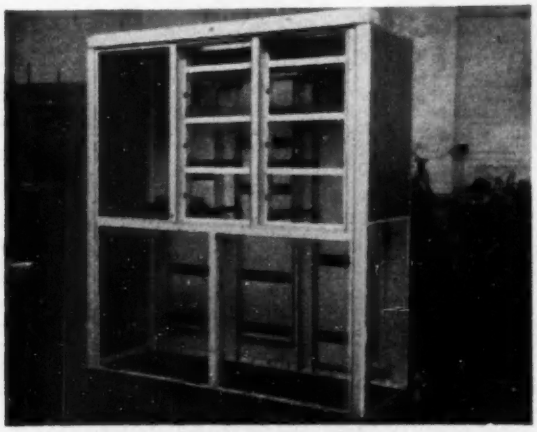
Have **you** a job to gladden our hearts?

SPENCER & SONS

(MARKET HARBOROUGH) LTD.

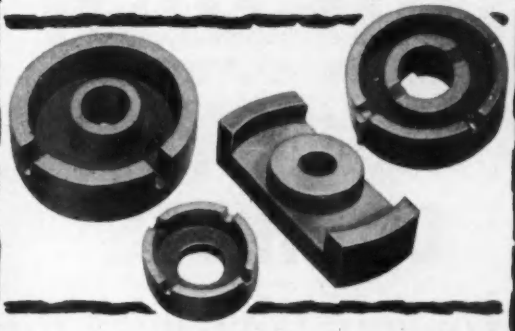
GREAT BOWDEN ROAD · MARKET HARBOROUGH · Tel. 2651/2

London Representatives: O'Neil & Co. Ltd.,
122 Cleveland Street, London, W.1. 'Phone: EUSton 4818-9

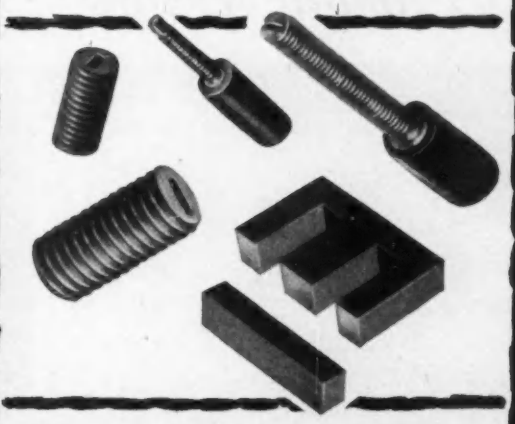


Partially completed main frame for housing electronics equipment.

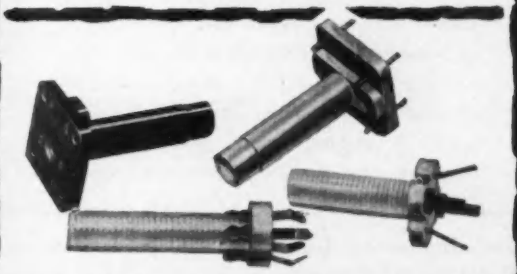
GECALLOY



radio cores



and formers



A complete range of insulated powdered iron cores is available, ideal for H.F. and V.H.F. working, in the following grades.

Grade ME for frequencies	100 kc/s to 50 Mc/s
Grade MF for frequencies	5 Mc/s to 200 Mc/s
Grade MA for frequencies	50 Mc/s to 300 Mc/s

A comprehensive range of formers and bobbins also available.

Write for catalogue.

SALFORD ELECTRICAL INSTRUMENTS LTD

TIMES MILL · HEYWOOD · LANCASHIRE Tel: HEYWOOD 6068

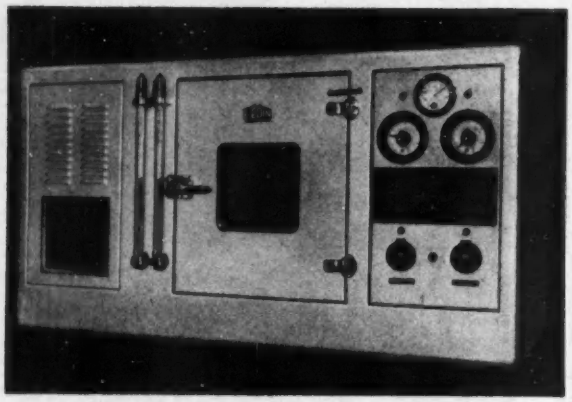
London Sales Office: Magnet House, Kingsway, W.C.2. *Tel:* Temple Bar 4668

A Subsidiary of THE GENERAL ELECTRIC CO. LTD. OF ENGLAND

HEDIN

HUMIDITY CABINETS

Ministry Approved for Climatic Testing



Catalogue No. 755 R Humidity Cabinet with automatic control and refrigeration.

Hedin Humidity Cabinets have been Ministry approved for both RCS11 and K114 specifications, and are available for (1) climatic testing of electrical and electronic equipment; (2) durability testing of plastics, rubber, paper, chemicals, containers, confectionery and protective coatings.

- ★ Construction is of stainless steel and aluminium
- ★ Automatic control
- ★ Standard range of sizes 18″ × 18″ × 17″ to 6′ × 6′ × 6′
- ★ Refrigeration available on all models
- ★ Non-standard units to special requirements
- ★ Designed for easy maintenance
- ★ Comprehensive auxiliary equipment available

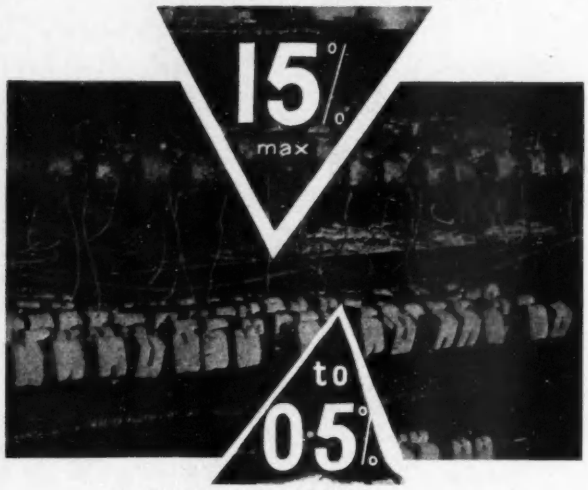
We shall be glad to demonstrate a cabinet in our works, or send you our leaflet L. 12

HEDIN LTD. Commerce Estate, S. Woodford, London, E.18.

Tel. BUCKhurst 6601/3.

WORKS: SOUTH WOODFORD & HAINAULT, ESSEX.

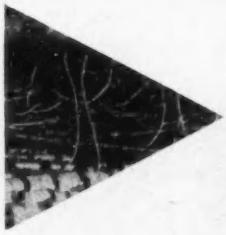
mechanical rejection rate (caused in impregnation processing) **reduced from . . .**



BY A SLEEVING WHICH COMBINES
THE ADVANTAGES OF INTEGRAL TEXTILE CORE
WITH PLASTICISED PVC SHEATH

Proof of increased throughput in production resultant from the use of NEW PERMANOID VS Sleeving is given by these figures established over several months by a manufacturer with a weekly output of 15,000 small transformers. The increased thickness in the plastic coating which ensures maximum resistance to impregnation varnishes and oils results from the availability of plasticisers evolved by PERMANOID Chemists. Electrical properties conform with BSS.

The textiles core eliminates shrinkage risk in baking and permits maximum flexibility.



Fully tropical the sleeving is suitable for continuous operating temperatures up to 105°C.

ELECTRICAL PROPERTIES

Insulation:- not less than 1000 megohms.

Breakdown Voltage:- 3000 volts.
when tested in accordance with BS 2848

AVAILABILITY

Delivery:- Immediate

Colours:-Eleven

Bore dia:- 0.5 mm to 5.0 mm.

PERMANOID

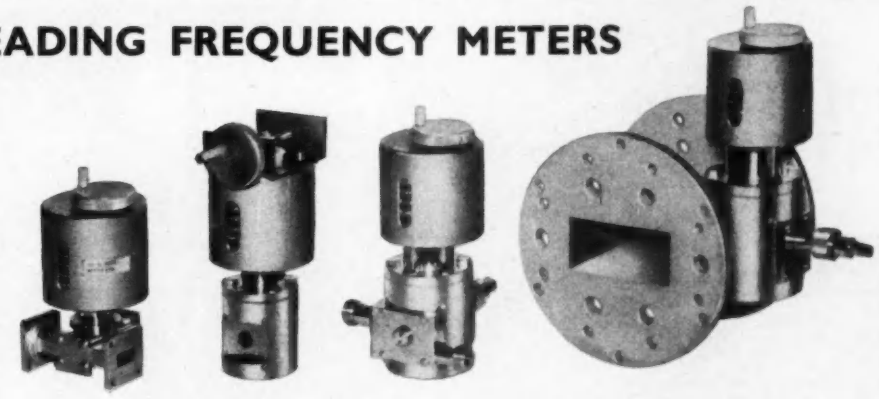
LIMITED

New Islington Manchester 4 COL 1371

Branches at LONDON, GLASGOW, NEWCASTLE, BRISTOL, WOLVERHAMPTON & DUBLIN

DIRECT READING FREQUENCY METERS

Type No.	Frequency range kMc/s
SL 7510	1.1 — 1.7
SL 5815	1.55— 2.5
SL 5212	2.5 — 4.0
SL 5590	3.3 — 4.9
SL 5174	3.8 — 5.9
SL 7599	4.5 — 7.29
SL 5585	5.4 — 8.6
SL 7100	7.05—11.2
SL 5205	8.2 —12.4
SL 7095	12.4 —18.0



The SIVERS LAB Direct Reading Frequency Meters enable a quick and accurate determination of frequencies in the Microwave region. The frequency range from 1 kMc/s to 18 kMc/s is covered by 10 models. Each model operates over the full waveguide band, with direct reading accuracy better than ±0.1%.
Attachments are available to enable the frequency meter to be included in the interior of a rack system with the control on the front panel.

By means of the exchangeable coupling elements

* End-connected waveguide or coaxial
* Passing waveguide or coaxial
* Crystal mount and lid

various circuit arrangements most suitable for the occasion, like reaction, absorption or transmission type of frequency meter can be formed by the user.

Please write for our complete microwave catalogue.

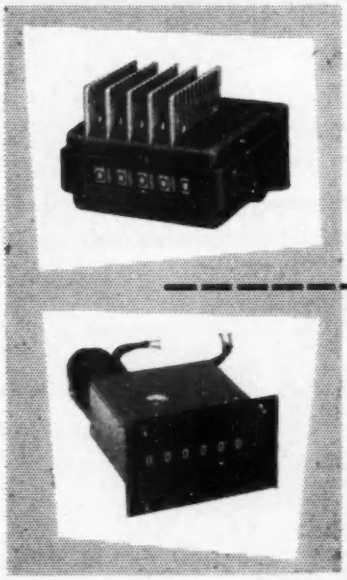
SIVERS LAB

P.O. BOX 42018
STOCKHOLM 42
SWEDEN
CABLE : SIVERSLAB

SALES AND SERVICE : B & K Laboratories Ltd., 4 TILNEY STREET, PARK LANE, LONDON, W.1 Telephone : GROsvenor 4567.

VEEDER

the name that counts



Let Veeder electrically-operated counters solve your counting problems. General Purpose or Heavy Duty long life magnetic counters will keep you in contact with facts. Suitable for most voltages, both AC and DC and fully resettable. Send to Division W for details.

Electrical and mechanical counters for all purposes.

VEEDER-ROOT LTD

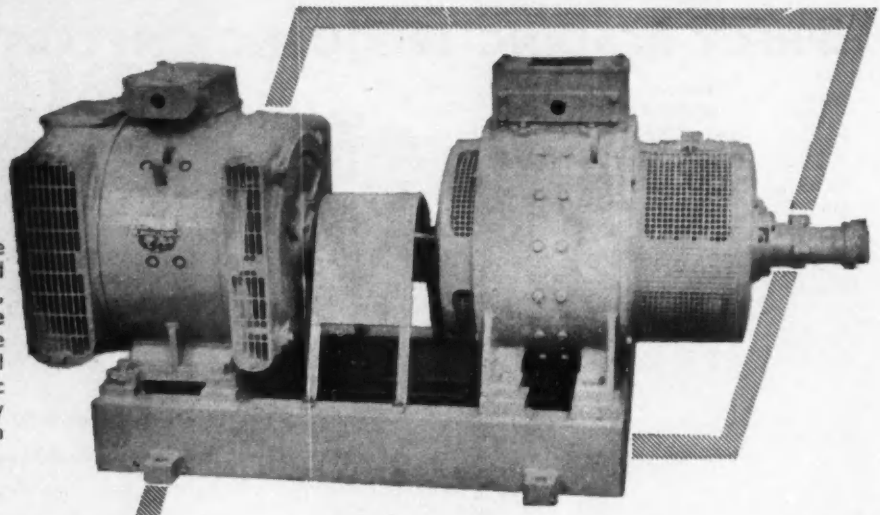
Division W King Henry's Drive New Addington Surrey

W 4

EE 30 257 *for further details*

SCIENTIFIC EQUIPMENT

With great experience in the realms of Aviation, Radar and Electronic Power Supplies, and Voltage Regulators, we supply machines tailor-made to suit the individual requirements of scientific laboratories and particularly of Technical Education establishments.



Variable frequency/voltage motor alternator set for Nottingham Technical College.

NEWTON DERBY

NEWTON BROS. (DERBY) LTD.

ALFRETON ROAD, DERBY

Manufacturers of Automatic Voltage and Current Regulators Rotary Transformers and Convertors, High Frequency Alternators and Motor Generators, special electrical equipment for Technical Education.

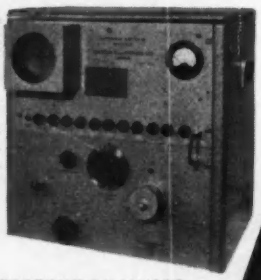
Why not consult us with your queries? Our Technical Engineers will gladly visit you to help in your problem.

Visit us on STAND X12 at the A.S.E.E. Electrical Engineers' Exhibition, EARLS COURT March 21st-25th, 1961

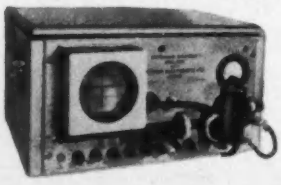
PHONE DERBY 47676 (4 LINES) GRAMS DYNAMO, DERBY
London Office: IMPERIAL BUILDINGS, 56 KINGSWAY, W.C.2

WINSTON INSTRUMENTS

Winston Electronics offer these instruments to all engaged in radar design and manufacture in X, S, or L Band.

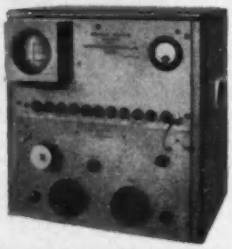


S-BAND SPECTRUM ANALYSER ▶
Frequency Range 2640/3200 Mc/s. Absolute Frequency Measurement ± 1.5 Mc/s. Relative Frequency Measurement ± 250 Kc/s. Sensitivity minus 85 db relative to 1mW at the input.

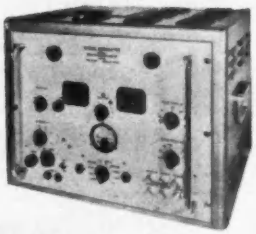


◀ X-BAND SPECTRUM ANALYSER
Frequency coverage 8,600/10,000 Mc/s. Absolute Frequency Measurement ± 1 Mc/s. Relative Frequency Measurement ± 250 Kc/s. Sensitivity minus 85 db relative to 1mW at the input.

SPECTRUM ANALYSERS



◀ L-BAND SPECTRUM ANALYSER
Frequency Coverage 1000–1500 Mc/s. 20–30 cms. Absolute Frequency Measurement ± ½ Mc/s. Relative Frequency Measurement ± 100 Kc/s. Sensitivity minus 85 db relative to 1mW at the input.



L-BAND SIGNAL GENERATOR
Frequency Range 800–2100 Mc/s in one band; single-dial control directly calibrated to ± 1%. Frequency Stability warm-up drift < .2% ambient ≏ drift .003% 1°C.

SIGNAL GENERATOR

In addition to the items featured the Winston range of electronic equipment includes:—

SEMI-DECADE OSCILLATOR	BECKMAN HELICAL PRECISION POTENTIOMETERS
RESISTOR BOXES	TURNS COUNTING DIALS
CAPACITOR BOXES	SHOCKLEY DIODES
VALVE VOLTMETER	STANDARD METAL CASES
TEMPERATURE CONTROLLER	

SUB-CONTRACT Full sub-contract facilities for the development and manufacture of Electronic Equipment, and Sheet Metal Work. Coil Winding Facilities. A.I.D. and A.R.B. approved. Write for full particulars of facilities available and catalogue of Instruments and Electronic Equipment to:— Dept. E.E.

WINSTON ELECTRONICS LIMITED

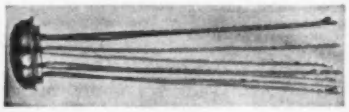
GOVETT AVENUE · SHEPPERTON · MIDDLESEX

Telephone: Walton-on-Thames 26321/6 Telegrams: Winston, Shepperton

EE 30 260 *for further details*

CORES

We specialise in the large scale production of all types of miniature toroidal coils wound on cores down to 50/1000" diameter (as shown below).

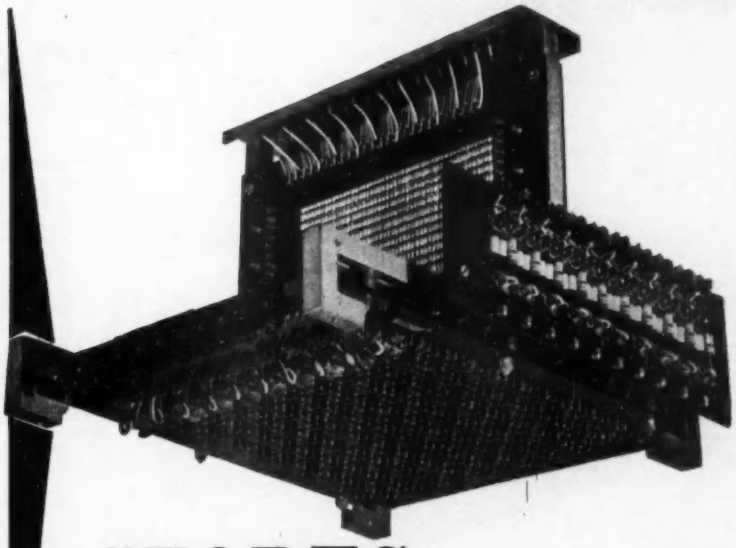


50/1000" OUTSIDE DIAMETER

Actual-size photograph showing one of our small ferrite ring cores mounted on glass base and encapsulated in resin. This particular core carries four windings of 20, 10, 10 and 5 turns of 48 s.w.g. enamelled wire.

Coils such as these are manufactured entirely in our Newport Pagnell factory.

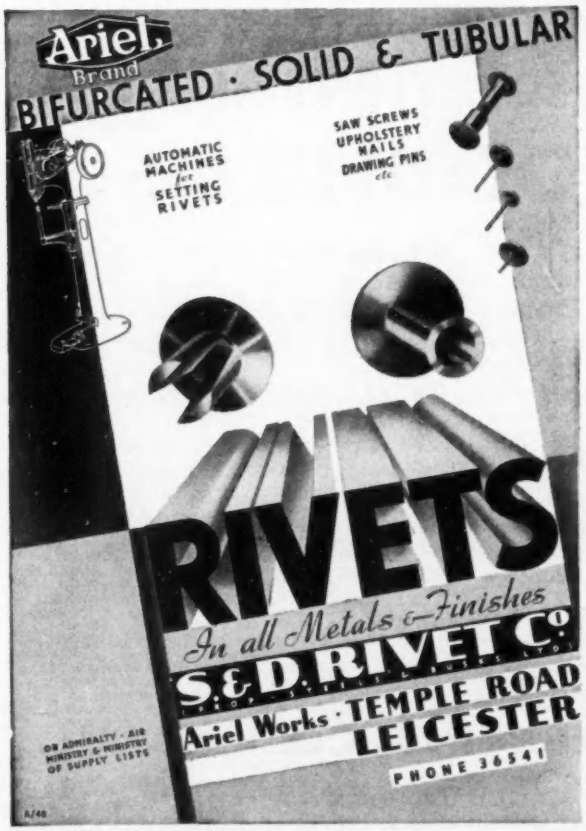
Please write for full details



STORES

In addition to the manufacture of coils and components we undertake the assembly of complex equipment such as this unusual Matrix Store for a 100-channel Analyser shown above.
(As supplied to A.E.I. Ltd., Instruments Division)

NEWPORT INSTRUMENTS (Scientific & Mobile) LIMITED
NEWPORT PAGNELL · BUCKS · ENGLAND
Telephone: Newport Pagnell 401/2



EE 30 261 *for further details*

Lexor

miniature low voltage
STABILISED POWER UNITS
Models LT. 12-05 & LT. 24-05

- Fully transistorised.
- Zener diode reference.
- Totally enclosed.
- Cool running.
- Floating output with earth terminal.
- Variable or pre-set control.

£25-7-0
each
with quantity discounts.

Delivery Ex Stock

PRECISION PERFORMANCE

1. Voltage ranges: 5.5-14V or 18-28V, continuously variable.
2. Output current 500 mA maximum.
3. Regulation: better than 0.15% for ±10% mains change and/or zero to full load.
4. Ripple: less than 2.5mV.
5. Impedance: less than 0.04Ω.

Full specification No. 138 from

LEXOR ELECTRONICS LIMITED
ALLESLEY OLD ROAD, COVENTRY
Telephone: COVENTRY 72614

EE 30 262 *for further details*

EE 30 263 *for further details*

NON-OVERLOADING

LINEAR PULSE AMPLIFIER NE 5202

of the Fairstein type. Designed for scintillation spectrometry and pulse height analysis studies, this new wide band amplifier features high gain, high gain stability, good linearity, low noise, excellent non-overloading characteristics, and operation at high duty cycles. Based on a double delay line differentiated system, it consists of three high gain feedback groups and a White cathode follower output. Premium tubes and the highest workmanship are used throughout.

Check these data:

Overload performance:	Fastest recovery of any available amplifier (5 microseconds for 100 times overload).
Maximum Voltage Gain:	50,000.
Gain Control Range:	1,200 : 1 with coarse and fine controls.
Gain Drift:	Better than 0.25% per week with stabilised supply.
Gain Stability:	Better than 1% for 10% change in mains voltage.
Input noise rms:	40 microvolts.
Output voltage:	±100 volts.
Output rise time:	0.2 microseconds.
Output pulse width:	1.2 microseconds.
Integral linearity:	0.15%.
Output impedance:	17 ohms.

Write for New Catalogue and Price List.

Also available, the following companion units: Pre-amplifier and cathode follower NE 5202A; Single-channel pulse height selector NE 5102; Highly stabilised E.H.T. supply NE 5302; Scanning Scintillation spectrometer NE 8601; Ratemeter NE 5401; Complete assembly for C14 and H3 counting.

Nuclear Enterprises (G.B.) Ltd.

BANKHEAD MEDWAY, SIGHTHILL, EDINBURGH, 11, SCOTLAND **Tel: CRA 5262**

Associated Company: Nuclear Enterprises Ltd., 550 Berry Street, Winnipeg, 12, Canada

HIGH RESOLUTION RECORDS ON WOODHILL'S

MINIATURE GALVANOMETER RECORDERS

A.R.L. Type 'A' 70 mm. 12 CHANNEL

A.R.L. Type 'E' 35 mm. 10 CHANNEL

MANUFACTURED UNDER ADMIRALTY LICENCE

BOTH THESE HIGHLY DEVELOPED OSCILLOGRAPH FILM AND PAPER TRACE RECORDERS WILL MEET THE MOST EXACTING DEMANDS OF THE MODERN RESEARCH TECHNICIAN.

DESIGNED FOR HIGH RESOLUTION, UNIQUE IN SIZE, DEPENDABLE AND CONVENIENT IN USE, THEY ARE INDISPENSABLE FOR THE MOST DIFFICULT RECORDING PROBLEMS WHERE HIGH EFFICIENCY INSTRUMENTS ARE A *SINE QUA NON*.

DESIGN. WE DESIGN AND MANUFACTURE RECORDING INSTRUMENTS AND ALLIED EQUIPMENT TO CUSTOMERS' SPECIFICATIONS.

WOODHILL ENGINEERING CO. LTD.

TROUT ROAD, YIEWSLEY, MIDDLESEX Telephone: WEST DRAYTON 2892 & 3168

EE 30 264 *for further details*

CLASSIFIED ADVERTISEMENTS

Run-on Classified—The charge for these advertisements is 7d. per word. Minimum charge, 14s. Box number, 2s. extra, except in the case of advertisements for "Situations Wanted", when it is free.

Specially Spaced Classified—50s. 0d. per single column inch.

Copy, with remittance, for the above advertisements, must be received before the 14th of the month for insertion in the following issue.

Display Classified—Full Page, £75 (based on specially spaced classified rates). Half Pages, Quarter Pages and Eighth Pages *pro rata*. Copy dates: With proofs, 5th of preceding month. Without proofs, 10th of preceding month. Blocks must be mounted.

Advertisements for publication should be addressed to:
Classified Advertisement Dept., **"Electronic Engineering", 28, Essex Street, Strand, London, W.C.2.**

OFFICIAL APPOINTMENTS

CENTRAL ELECTRICITY GENERATING BOARD. Laboratory Technicians required for the following types of work at the Research Laboratories, Leatherhead, Surrey: (a) The development and construction of prototype mechanical and electrical apparatus and test rigs. Applicants should have served a recognised period of training and have considerable practical experience and ability, preferably in laboratory and other prototype development work, and must be capable of precision fitting and operating a wide range of machine tools to tool-room limits. A good knowledge of engineering materials is required. Applicants must have the ability to work with a minimum of supervision, to discuss problems with scientific staff and to give practical interpretation to their needs by the manufacture of experiemntal equipment, etc., in accordance with requirements. (b) The expanding Instrument Services Group is responsible for supplying the instrument needs of the Laboratories, and the field of work covers installation, testing, calibration, and maintenance of a wide range of electricals electronic, electromechanical and scientific instruments, both novel and conventional. Applicants should have several years experience with commercial and/or industrial instruments and equipment, and be capable of working with the minimum of supervision. Preference will be given to candidate, who have completed indentured apprenticeship with an industrial user of instruments or of instrument manufacturer. The possession of an Ordinary National Certificate or City and Guilds Certificate in instrument maintenance would be an added qualification. The appointments, which are permanent and pensionable, carry staff status, and are based on a 38 hour/5 day week, with annual leave rising to a maximum of 4 weeks. Salaries within the range £650-£940 p.a. Applications stating age, qualifications, experience, present position and salary, to the Personnel Officer, 24/30, Holborn, London, E.C.1, as soon as possible. Envelopes should be marked "Confidential Ref. EE/471". W 5042

MIDDLESEX COUNTY COUNCIL, Education Committee, Brunel College of Technology, Woodlands Avenue, W.3. Principal: Dr. J. Topping, M.Sc., D.I.C., F.Inst.P., Department of Electrical Engineering and Electronics. Applications are invited for the post of Assistant Lecturer, Grade B, to teach Electronics in the Diploma in Technology and Degree courses. The post requires a good understanding of the fundamentals and applications of Electronics and, while industrial or research experience is necessary, teaching experience is desirable, but not essential. The Department is responsible for Electronics throughout the College and provides an excellent opportunity to obtain a broad theoretical and practical experience. Every encouragement is given to undertake research, for which the Department is well equipped. The College, which occupies very pleasant modern buildings, is developing rapidly. Salary will be within the range of £828 to £1,486 dependent upon qualifications and experience. Further details and forms of application may be obtained from the Principal, to whom completed forms should be returned within 14 days. C. E. Gurr, M.Sc., Ph.D., Chief Education Officer. W 5033

MIDDLESEX COUNTY COUNCIL. Education Committee. Willesden Technical College, Denzil Road, Willesden, N.W.10. Principal: L. L. Allen, B.Sc.(Eng.), A.K.C., M.I.Mech.E., M.I.E.E., M.I.Prod.E. Department of Electrical Engineering. Applications are invited from graduates for the following post: Senior Lecturer to teach Radio Technology or Electronic Engineering up to Post-Higher National Certificate standard. Candidates should have good industrial or research experience. Willesden Technical College is a large college situated within a short distance from the centre of London. The college offers to a high standard a large range of courses in Mechanical and Electrical Engineering. Engineers interested in an academic career will be given every opportunity and encouragement to take an active part in research and development projects. Salary within the range of £1,588 to £1,801 p.a. Further particulars and application forms (foolscap S.A.E.) from the Clerk to the Governing Body, 163 Willesden Lane, N.W.6 (to be returned in two weeks). C. E. Gurr, M.Sc., Ph.D., Chief Education Officer. W 5051

MINISTRY OF AVIATION require Engineers in their Electrical Inspection Directorate at Bromley, Kent, to assist in technical direction, Post A Electronic valves and transistors Post B Special purpose batteries. Duties include control of test-laboratories, close liaison with research and development establishments, manufacturers, etc., and offer a unique opportunity to gain wide experience in these fields. Salary range £820-£1,300 according to age, with good prospects of promotion to high grades. Five day week, generous leave and opportunities to compete for established pensionable posts. The normal duties and responsibilities of these posts are at professional level and require candidates who possess the educational qual. and practical training required for Corporate Membership of the Institution of Electrical Engineers. Exp. in development, manufacture of inspection of electronic valves and/or transistors for Post A and of primary and/or secondary batteries for Post B, is desirable. Forms from Ministry of Labour, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.830/OA. W 5038

MINISTRY OF AVIATION requires Technician at Moston, Manchester, to assist in the supervision of an approved inspection organization at a major guided weapon works with particular reference to material and process control and component testing associated with production of missile electronic equipment. Qualificarions: Recognized apprenticeship or equivalent training. O.N.C., C. & G. Final Certificates or equivalent. Experience in the manufacture and control of workshop processes associated with production of electronic equipment. Some knowledge of testing such equipment an advantage. Salary, £950-£1,085 (plus pay supplement). Good prospects for promotion and pension. Technical College courses sponsored for suitable candidates. Application forms from Manager (PE.422), Ministry of Labour Professional & Executive Register, Atlantic House, Farringdon Street, London, E.C.4. W 5045

MINISTRY OF AVIATION, Malvern, Worcs., requires Technician for preparation of technical publications on electronic equipment. Qualifications: Recognized engineering apprenticeship or equivalent training, O.N.C., C. & G. Final Certificates or equivalent. Sound knowledge of electronics. Experience of writing or editing technical publications an advantage. Salary: £925-£1,055 plus 4 per cent. Good prospects for pension and promotion. Technical College courses sponsored for suitable candidates. Application forms from Manager (PE.483), Ministry of Labour, Professional & Executive Register, Atlantic House, Farringdon Street, London, E.C.4. W 5059

MINISTRY OF AVIATION, Stevenage, Herts. Technician required for supervision of contractor's inspection on a major Guided Weapon project. Qualifications: Recognised engineering apprenticeship. H.N.C. or equivalent. Good theoretical knowledge and previous practical experience in electrical engineering, including some electronics. Prior experience in G.W. work not essential. Knowledge of general mechanical engineering principles as applied to electrically operated hydraulic or pneumatic devices an advantage. Salary: £1,055-£1,295 plus 4 per cent pay supplement. Good prospects for pension and promotion. Technical College courses sponsored for suitable candidates. Forms from Ministry of Labour, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.7/1A. Closing date, 24 February 1961. W 5058

MINISTRY OF AVIATION, Aberporth, Cardiganshire, requires Technician to supervise section engaged on maintenance and operation of telemetry equipment and tape recording and replay systems. *Quals.* Recognised eng. apprenticeship or equiv. training. ONC, C. & G. Final Certs. or equiv. Some years exp. of communications receivers or radar equipt. Knowledge of tape recording techniques and exp. of telemetry systems an advantage. *Salary* £859 (age 28)—£961. Good prospects for promotion and pension. Application forms from Manager (PE.491), Ministry of Labour, Professional & Executive Register, Atlantic House, Farringdon St., London, E.C.4. W 5069

NATIONAL PHYSICAL LABORATORY, Teddington, Middlesex, requires in Ship Division either at Teddington or Feltham: (1) Senior Scientific Officer, to lead small team on hovercraft research. Candidate must have imagination, initiative and some practical research experience with specialised knowledge of aerodynamics and/or hydrodynamics. (2) Scientific Officer or Senior Scientific Officer, mechanical engineer, knowledge of fluid dynamics for experimental and analytical investigations into ship vibration problems, particularly those associated with propeller excited forces. Candidates must be able to develop and apply mathematical methods to guide and interpret model experiments. Knowledge of electronics desirable. Quals.: 1st or 2nd Class Honours Degree, or equiv. For the Senior Scientific Officer posts, at least 3 years' post graduate research exp. required. Salaries: Scientific Officer £730-£1,205; Senior Scientific Officer £1,330-£1,640. Forms from Ministry of Labour Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.989/OA. Closing date 15th February, 1961. W 5039

RADIO AND UPPER ATMOSPHERE RESEARCH. Physicists, Engineers and Mathematicians required by D.S.I.R. at Radio Research Station, Ditton Park, Slough as Scientific Officers or Senior S.O.s to investigate the upper atmosphere and the space between the earth and sun, with particular reference to the propagation of radio waves through those regions, and associated problems of terrestrial and space communications. Work concerned with experiments on ground, and in rockets and satellites. On experimental side it involves the design and use of suitable radio equipment including low noise amplifiers for use with radio telescope; research on cosmic rays, vacuum physics, and spectroscopy. For theoretical studies knowledge of magnetohydrodynamics or of plasma physics will be useful. Digital computer is available for the study of orbits of artificial satellites. Quals.: 1st or 2nd hons. degree or equiv. in Physics, Elec.-Eng., or Maths., with at least 3 years' post graduate exp. for Senior Scientific Officer grade. Salary ranges S.O. £690-£1,144; S.S.O. £1,250-£1,540. Normal promotion prospects to Principal S.O. in the mid-thirties (range of £1,600-£2,275). Forms from Ministry of Labour, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.581/OA. W 5037

OFFICIAL APPOINTMENTS (Cont'd.)

PAISLEY TECHNICAL COLLEGE, George Street, Paisley. Scottish Central Institution. Electrical Engineering Department. Applications are invited from Honours Graduates with industrial experience for appointments as lecturers in (*a*) Electric Power Engineering and (*b*) Electronic or Telecommunication Engineering. The commencing salary will depend upon experience subsequent to graduation and will increase by £50 p.a. to a maximum of £1,700 p.a. Courses are provided in the department for the London External B.Sc. Degree and the I.E.E. Part III examinations. Further particulars may be obtained from the undersigned and applications should be submitted not later than 18 February, 1961. H. N. Henry, Principal, Paisley Technical College, 28-40 George Street, Paisley. W 5047

PATENT EXAMINERS AND PATENT OFFICERS. Pensionable posts for men or women for work on the examination of Patent applications. Age at least 21 and under 29 on 31.12.61, with extension for Regular Forces Service and Overseas Civil Service. Qualifications: normally a degree or a Diploma in Technology, with First or Second-Class Honours in Physics, Chemistry, Engineering or Mathematics, or equivalent attainment, or professional qualification, e.g., A.M.I.C.E., A.M.I.Mech.E., A.M.I.E.E., A.R.I.C., A.Inst.P. London salary, £759 to £1,704; provision for starting pay above minimum. Promotion prospects. Write, Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting S/128/61. W 5055

PLYMOUTH AND DEVONPORT TECHNICAL COLLEGE. Principal, E. Bailey, B.Sc., F.R.I.C., A.M.I.Chem.E. Required, as soon as possible, Assistant Lecturer, Grade A, for Radio Officers' courses with opportunities for taking other radio and electrical courses within the Electrical Engineering Department. Candidates should hold a First Class P.M.G. Wireless Telegraphy Certificate and M.O.T. Radar Maintenance Certificate. Seagoing and/or teaching experience are added qualifications. Salary: £520 by £27 10s. to £1,000 per annum with additions for approved experience, qualifications and training. Forms and particulars (s.a.e.) from Clerk to the Governors, Education Offices, Cobourg Street, Plymouth, to whom they should be returned as soon as possible. W 5057

RADIO TECHNICIANS IN CIVIL AVIATION. Men aged 19 or over for interesting work providing and maintaining aeronautical telecommunications and electronic navigational aids at aerodromes and radio stations in the U.K. Fundamental knowledge of radio or radar with some practical experience essential; training provided on special types of equipment. Salary according to age and station, approx. £670 at age 25 rising to £795. Prospects of permanent pensionable posts. Good opportunities for those who obtain O.N.C. in Elec. Eng. or certain C. and G. Certificates for promotion to posts with maximum salaries of £950, £1,085 and £1,335. Apply to the Ministry of Aviation (Est.5(a)/RT), Berkeley Square House, London, W.1 or to any Employment Exchange quoting Order No. Westminster 3552. W 5027

TECHNICIAN at the Hospl. for Sick Children, Gt. Ormond St., W.C.1 for maintenance and construction of special hospl. equipment. Some knowledge of light Eng. essential. Salary £600×£20 (2) ×£25 (4)-£740 p.a. Write for application forms to House Gov. W 5035

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY- Sackville Street, Manchester, 1. A Senior Technician or a Chief Technician required in the Chemistry Department to join a chemistry research group and specifically to control and operate a High Resolution Nuclear Magnetic Resonance Spectrometer. Previous experience in this technique is not essential, but candidates should have a good knowledge of electronics or applied physics, and be interested in the further development of the technique for use in chemical research. Salary: Senior Technician £700-£765 per annum (with additions for approved qualifications); Chief Technician £825-£925 per annum. 40 hour week. Superannuation scheme. Applications with full details quoting reference No. C.6 to The Bursar. Closing Date: 14th February, 1961. W 5040

THE QUEEN'S UNIVERSITY OF BELFAST. The Senate of The Queen's University of Belfast invites applications for two Lectureships in Engineering Mathematics from 1 October, 1961. Salary range, £1,050 to £1,850, plus contributory pension rights under the F.S.S.U. Initial placing on the salary scale will depend on qualifications and experience. Applications should be received by 10 March, 1961. Further particulars may be obtained from G. R. Cowie, M.A., LL.B., J.P., Secretary. W 5048

THE QUEEN'S UNIVERSITY OF BELFAST. Applications are invited for a post of Research Technician who will be general research assistant in connection with fluid dynamics, structures, soil mechanics, etc. The work will be mainly concerned with electronic equipment and will involve design, construction and development. Candidates should, therefore, have a suitable theoretical and practical background, but a degree is not essential. Initial salary range, £800-£1,000 according to qualifications. Applications should be addressed to Professor A. H. Naylor, Civil Engineering Department and received not later than 28 February, 1961. W 5049

THE SCIENTIFIC CIVIL SERVICE needs men and women for pensionable posts as (*a*) Experimental Officers and (*b*) Assistant Experimental Officers in Mathematics, Physics, Meteorology, Chemistry, Metallurgy, Biological Sciences, Engineering, Miscellaneous (Geology, Library and Technical Information Services). Candidates must, on 31.12.61, be at least 26 and normally under 31 for (*a*), and at least 18 and normally under 28 for (*b*). Qualifications should normally include H.S.C., or G.C.E., or equivalent, or H.N.C., a University Degree, or a Diploma in Technology. Provisional admission if taking examinations in 1961. London salary scale : (*a*) £1,107-£1,376; (*b*) £465 10s. (at 18) to £826 (26 and over), rising to £1,009. Promotion prospects. Further education facilities. Write, Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting S/94-95/61. W 5060

THE SCIENTIFIC CIVIL SERVICE needs men and women for pensionable posts as Assistants (Scientific). Ages at least 17 and normally under 27 on 31.12.61, with appropriate educational and technical qualifications (normally G.C.E. with passes at "O" or "A" level in 4 distinct subjects, including English Language and a Scientific or Mathematical subject, or O.N.C., or equivalent qualifications) and at least 1 year's experience in (1) Engineering or Physical Sciences, or (2) Chemistry, Bio-Chemistry or metallurgy, or (3) Biological Sciences, or (4) Geology, Meteorology, or skilled work in laboratory crafts such as glassblowing. Salary: London, £361 10s. (at 17) to £571 (at 25 or over), rising to £743. Promotion prospects. 5-day week generally. Write, Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting S/59/61. W 5056

THE SCIENTIFIC CIVIL SERVICE needs men and women for pensionable posts as (a) Senior Scientific Officers and (b) Scientific Officers in all major scientific fields, including Physics, Engineering, Chemistry, Meteorology, Mathematics and Biological Subjects. Age limits: (a) at least 26 and under 32, (b) at least 21 and under 29. Extension for regular Forces service and Overseas Civil Service. Qualifications: normally a degree, or a Diploma in Technology, with first or second class honours in science, mathematics or engineering, or equivalent attainment; additionally for (a), at least 3 years' relevant post-graduate experience. Selection by interview. London Salaries (subject to review): (a) £1,382-£1,704; (b) £759-£1,258. Provision for starting salary above minimum. Promotion prospects. Write Civil Service Commission, 17 North Audley Street, London, W.1 for application form, quoting (a) S/53/161, (b) S/52/161. W 5068

UNIVERSITY OF BELFAST. The Senate of The Queen's University of Belfast invites applications for a Lectureship in Light Electrical Engineering from 1 October 1961. Salary range, £1,050 to £1,850 plus contributory pension rights under the F.S.S.U. Initial placing on the salary scale will depend on qualifications and experience. Applications should be received by 15 March 1961. Further particulars may be obtained from G. R. Cowie, M.A., LL.B., J.P., Secretary. W 5064

UNIVERSITY OF EDINBURGH. Applications are invited for I.C.I. Research Fellowships in Biochemistry, Chemistry, Engineering, Pharmacology, Physics or Chemical Technology (Chemical Engineering), normally tenable for a period of three years. Some appointments will date from 1st October, 1961 (or earlier in the case of selected candidates who may be available before that date). The initial salary will depend upon qualifications and experience, but will normally be within the range £800 to £1,100 per annum, together with F.S.S.U. benefits and family allowance. In the case of an overseas applicant, the University is also prepared to consider the provision of an allowance towards defraying the cost of travel to and from Great Britain. Forms of application and further particulars may be obtained from the undersigned. Applications (two copies) should be submitted not later than 16th February, 1961. Charles H. Stewart, Secretary to the University. W 5036

UNIVERSITY OF NOTTINGHAM. I.C.I. Research Fellowships. Applications are invited for Imperial Chemical Industries Research Fellowships in Chemistry (including Agricultural Chemistry), Physics, Pharmacy, Engineering, Metallurgy and related subjects, tenable at the University of Nottingham. A number of appointments may be made as from 1st October 1961, with a normal tenure of three years. The salary will be within the scale £800-£1,100 per annum depending on qualifications and experience. Fellows will have status as members of the academic staff and will be eligible for F.S.S.U. benefits and children's allowances. Further particulars and forms of application may be obtained from the Registrar, to whom applications must be returned not later than 1st March, 1961. W 5034

UNIVERSITY OF NOTTINGHAM. Applications are invited for two Lectureships and Assistant Lectureships in Electrical Engineering. Candidates should have some industrial experience and be interested in teaching or research in one or more of the following fields: Electrical Machines; Physics of Electrical Materials; Computers; Electronics. Salary Scales: Lecturer £1,050 to £1,850; Assistant Lecturer £800 to £950; initial salary according to qualifications and experience. Superannuation under F.S.S.U. with children's allowances. Conditions of Appointment and Form of Application, to be returned by 18th February, 1961, from the Registrar. W 5066

SITUATIONS VACANT

A VACANCY EXISTS for an Electronic Engineer at the Redhill Laboratories of Zonal Film (Magnetic Coatings) Ltd. Age 20-35 years. H.N.C. or Institute. Applicants will be expected to be familiar with magnetic recording techniques and circuits. Knowledge of computors and computor circuits would be considered an advantage. Apply, in first instance, to Chief Electronic Engineer, The Tower, Hammersmith Broadway, W.6. W 2011

AEON LABORATORIES REQUIRE additional staff for the testing, installation and maintenance of electron microscopes and X-ray equipment. Previous experience with these instruments is not essential to applicants with good training in electronics or vacuum techniques. The post could be filled by either a young graduate in Physics or Electrical Engineering, or an engineer with H.N.C. and some years' experience. Pleasant working surroundings. 5-day week. Pension scheme. Apply, giving details of education and experience, to Aeon Laboratories, Beech Hill, Ridgemead Road, Englefield Green, Egham, Surrey. W 5063

BAILEY METERS & CONTROLS LTD., Purley Way, Croydon, Surrey. Technical Staff at all levels are required for our Development Division. A comprehensive range of measuring and control instruments is continually being expended to meet the growing needs of the Nuclear, Supply and Process Industries. A minimum qualification of O.N.C. with some experience of Electronics, preferably including transistor circuitry, is required. The ability successfully to conceive, develop and follow through to production an instrument design, is expected of the more senior applicants. Junior personnel will assist in the development and testing in the laboratories. Draughtsmen, senior and junior, are needed to participate in the production of designs and the putting of these into production. Apply to Chief Development Engineer at the above address. W 2008

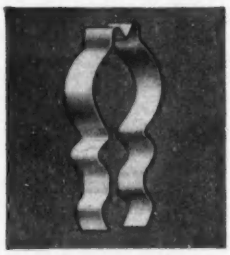
ELECTRONIC DRAUGHTSMAN to draw circuit diagrams and electronic instrument layouts, compile parts lists and prepare printed circuit masters. Competence in good drawing office practice and familiarity with electronic instruments and component and with assembly, mounting and wiring methods are essential. This attractive opportunity offers wide responsibility and a generous salary. State fully career details and salary required to Technical Director, Shandon Scientific Co. Ltd., 6 Cromwell Place, S.W.7. W 5053

CLASSIFIED ADVERTISEMENTS

continued on page 210

LS products for the Electronics Industry

(Ex stock from works or London office).



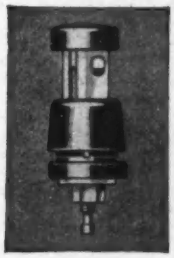
Top illustration shows the clip greatly enlarged whilst the lower picture shows the clip actual size and also the method of fixing.

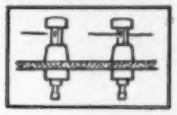
TRANSISTOR CLIPS

in Beryllium Copper

(Patent and Type Approval applied for)

Of compact design, and taking up no more room than the Transistor itself, these Clips, manufactured from Beryllium Copper and formed so as to assist heat dissipation, are designed to suit cylindrical Transistors such as the Mullard OC.72 for fixing horizontally to printed circuit boards.





Pressure on the terminal cap opens the transverse hole and allows the wire or pin to be inserted. Release pressure and wire or pin is firmly held in position.

SPRING LOADED WIRING TERMINAL

Designed for mounting on panels up to $\frac{1}{4}$" thick, the terminal accepts wire ends or pins up to $\frac{1}{8}$" diameter and provides a quick and simple connection, secure and proof against vibration. Terminals are available from stock with Black or Red Thermo-plastic fittings or other colours to order.

Ratings :—Current 5 amp. Test Voltage 1000 V., with contact resistance. (Patent and Type Approval applied for).

for Reliability . .

LEAVE IT TO **Lewis** OF REDDITCH

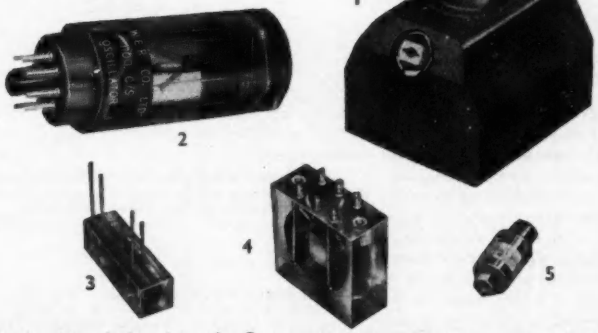
SPRINGS, PRESSWORK AND WIRE FORMS TO FINE LIMITS

THE LEWIS SPRING CO. LTD., Resilient Works, Redditch.
London Office: 122 High Holborn, W.C.I.

Send 2/6 P.O. for our 40 page booklet on spring design with full technical data. It is an invaluable reference for your design department.

POTTED COMPONENTS

We are specialists in the design and manufacture of encapsulated components in Epoxy and Polyester resins. Illustrated below are a few typical examples. Our technical representative would be pleased to discuss their use for your particular applications.



1. Probe No. 4—Used by the Post Office for fault location on telephone cable routes.

2. Fixed Frequency Oscillator—On a standard octal base and encapsulated in epoxy resin. *Output:* 10 MW into a 600 ohm load. *Frequency:* As required within the range 700-2000 C.P.S. sinusoidal.

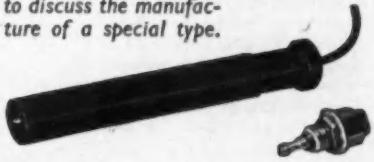
3. P.60 Insert—An insert in a T/V distribution line, potted to withstand the weather.

4. Pulse Transformers—A toroidel winding on a mu-metal core: all connections are brought out to strong turret lugs moulded in the base of the casting.

5. Potentiometer Mounting—Here the material is used as an isolator, the component being used as a potentiometer mounting.

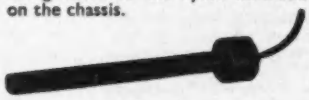
PLUGS & SOCKETS

The examples shown here are representative of the wide range available, and we are always happy to discuss the manufacture of a special type.



PROBE AND SOCKET

Designed with the contact shrouded in order to monitor various points of a curcuit, the monitor points being taken to the nylon moulded socket mounted on the chassis.



TEST PROBE

Designed to monitor any point that is terminated on a standard Ediswan Polytag.

PLUGS No. 127 and 222

Manufactured specially for the G.P.O. An example of the development of small components undertaken by the Company.

WHITELEY ELECTRICAL RADIO CO. LTD. WB **MANSFIELD · NOTTS.**

Telephone: MANSFIELD 1762/5

SITUATIONS VACANT Cont'd.)

ELECTRONIC ENGINEER. Interesting, varied work on scientific instruments. Small, rapidly expanding company provides friendly and informal conditions with good opportunities for advancement. Essential qualification: a thorough understanding of electronic valve circuitry at d.c. and low frequencies, both theoretical aspects and practical application. Experience of transistors, printed circuits and/or magnetic amplifiers an advantage. State fully career details and salary required to Technical Director, Shandon Scientific Co. Ltd., 6 Cromwell Place, S.W.7. W 5052

ELECTRONIC ENGINEER REQUIRED for technical advice and sales activities in the fields of telecommunications and for data transmission. A fully qualified man of about 25-30 years with practical experience would be suitable. Should be prepared to travel in U.K., and occasionally to Europe. Some time would also be spent at the Company's associated laboratories in Egham. Pension scheme. Apply in writing giving full details of education, qualifications and experience to W. Wykeham & Co., 17-19, Cockspur St., Trafalgar Square, London, S.W.1. W 5043

ELECTRONIC ENGINEER. Our progressive policy creates a vacancy in a new laboratory for an Electronic Engineer (age 25-35) to assist in the design and development of control circuits and counting techniques. We offer the advantages of working for a small firm backed by the resources of a large group. The prospects in this new field are excellent and the salary attractive. Applicants should preferably have H.N.C. However, the prime requirement is a versatile approach to electronic problems. Reply, in confidence, to Managing Director/TM39, De Grave, Short & Co. Ltd., Cray Valley Works, St. Mary Cray, Orpington, Kent. W5065

ELECTRONIC INSTRUMENT MAINTENANCE and Test Engineers. Experience Tektronix and Hewlett-Packard preferred but not essential. This is a Staff appointment with 37½-hour week and non-contributory pension and life insurance scheme. Employment initially at Highgate, after April at Camden Town, where canteen facilities will be offered. Write in confidence or telephone F. R. G. Webb, Livingston Laboratories Limited, Retcar Street, London, N.19. Telephone: ARC 6251. W 5028

ELECTRONICS ENGINEER, preferably with about three yeras' experience in transistors or transformers, is required by Hilger & Watts Ltd., makers of scientific instruments, in their London Laboratories, to assist in the development of instruments used in Process Control. The successful applicant should be at least up to H.N.C. standard and will need to show the ability to work on his own initiative on general circuitry design and development. This post offers considerable scope in a progressive company in a rapidly expanding industry, and applicants should send full details to the Chief Personnel Manager, 98 St. Pancras Way, N.W.1. W 5054

JUNIOR ENGINEER REQUIRED for interesting development projects at Aeon Laboratories. These will involve both mechanical and electrical devices, and will call for ingenuity and original thinking. Qualifications: O.N.C. or H.N.C.; experience in design work or drawing office an advantage. Age range 22-27. Attractive working conditions. 5-day week. Pension scheme. Apply, with details of qualifications and experience, to Aeon Laboratories, Beech Hill, Ridgemead Road, Englefield Green, Egham, Surrey. W 5062

LANCASHIRE DYNAMO ELECTRONIC PRODUCTS LTD., Rugeley, Staffs. "Electronic Engineers to Industry". If you are trained to degree or H.N.C. standard in Electrical Engineering and have a good knowledge of Thermionic Valve Circuits, you are just the kind of man we are seeking for our Laboratories. Should you have also a good working knowledge of Transistor Circuit Design, so much the better, but if not, do not be deterred—we can bring you up to date and beyond! Our Laboratories are a fertile breeding ground of novel ideas, stimulated by a continual stream of inquiries from all branches of industry. If you are looking for opportunities for well-rewarded achievement, write to us at the address above, quoting reference SA/WFH. Your reply should include such personal data as you feel will interest us and will, of course, be treated in absolute confidence. W 5041

LOUIS NEWMARK LIMITED, leading company in the design of auto pilots for helicopters are expanding their facilities at their Development Laboratories at Croydon and have the following vacancies to be filled immediately. Engineers and Assistant Engineers with degree or H.N.C. and experience in the field of light electrical engineering, electronics, electro mechanical devices or semi conductors, to work on the development, installation and flight testing of automatic pilots. Salary commensurate with experience. Pension Scheme. Apply in writing, giving full particulars to: Personnel Officer, Louis Newmark Ltd., Prefect Works, Purley Way, Croydon, Surrey. W 351

OVERSEAS. Electronic Technicians are required by an Oil Exploration Company with Headquarters in the U.K. Men should be single on joining. Work will include the maintaining and operating of field equipment often under conditions of desert, jungle, and swamp. The equivalent of an H.N.C., with practical experience in electronics, is essential. Tours overseas are of up to two years followed by home leave. Write with full particulars, covering any time spent in the Forces, to Box No. W 356.

THE DE HAVILLAND ENGINE COMPANY LIMITED requires Technicians to work in the Electro Dynamics Department on specialized instrumentation which has a wide variety of applications in the aero-engine and commercial fields. Inquiries are invited from: (1) Electronic Engineers with experience of electronic methods in the field of measurement; (2) Physicists with general instrumentation experience; (3) Mechanical Engineers with a knowledge of vibration or stress analysis. Good salaries will be paid to the successful applicants who will be engaged at Stag Lane or at the Company's Hatfield, Hertfordshire, Test Site. Please write with full details of experience, qualifications and present salary, to: The Personnel Officer (Ref. SC54), The de Havilland Engine Company Limited, Stag Lane, Edgware Middlesex (Member Company of the Hawker Siddeley Group). W 5061

THE DRAYTON REGULATOR & INSTRUMENT CO. LTD. The Research Department requires two engineers and three assistants to work on the electronic, light electrical and mechanical design of new projects, and their applications. They will have monthly staff status and receive three weeks annual holiday. Applications stating experience, qualifications and age should be addressed to: Dr. A. A. C. March, Drayton Regulator & Instrument Co. Ltd., West Drayton, Middx. W 5044

THE LABORATORY of Engelhard Hanovia requires Technical assistants to undertake design and development of electro-mechanical assemblies, special purpose transformer equipment and discharge lamps. Suitably qualified applicants should write in the first instance to The Research Manager, Engelhard Hanovia Lamps, Bath Road, Slough. W 5014

TRANSFORMER DESIGNER is required by Pye Ltd. of Cambridge to assist with the design of a wide range of transformers used in the Group, including power types up to 5 kVA, audio and other miscellaneous types for radio, television and electronic applications. This vacancy is for an experienced designer but applications for training will also be considered from otherwise suitable candidates with mathematical ability. Please write, quoting "TDS", to the Chief Engineer, Pye Ltd., Cambridge. W 2006

YOUNG ELECTRONICS ENGINEER required by well-known London firm of Chartered Patent Agents with expanding electrical practice. Must have Honours Degree, should be aged 25 or under and be prepared to study for qualification as Chartered Patent Agent. Write, giving full particulars as to age, qualifications, etc., to Box No. DA4339 c/o Whites, 72 Fleet Street, London, E.C.4. W 5019

SITUATIONS WANTED

AGENT, WITH SUITABLE CONNECTIONS, available for sales and service of Electronic products. Write John Bisco, 349 High Street, Cheltenham. W 2003

ENGINEER REQUIRES Sales Management, or Senior Sales Post, with company supplying the Electronics Industry. Extensive connection with designers and buyers throughout London and Home Counties. Experience in design of metal fabrications, woodwork, plastics and packaging. Box No W 2010.

QUALIFIED ELECTRICAL ENGINEER requires part-time work in the London area. Development, sales, manufacture undertaken. State type of work. Box No. W 2007.

CLASSIFIED ADVERTISEMENTS
continued on page 212

NEW LINE OUTPUT BEAM TETRODE

EDISWAN MAZDA 30P19

This new line output beam tetrode is specially suitable for use with 110° cathode ray tubes in a.c./d.c. television receivers.

Heater Current (amps)	I_h	0.3
Heater Voltage (volts)	V_h	25

TENTATIVE RATINGS AND DATA

Maximum Design Centre Ratings

Anode Dissipation (watts)	$P_{a(max)}$	10
Screen Dissipation (watts)	$P_{g_2(max)}$	5
Cathode Current (mA)	$I_{k(max)}$	160
Anode Voltage (volts)	$V_{a(max)}$	400
Peak Anode Voltage—		
Pulse Positive* (kV)	$V_{a(pk)max}$	7†
Screen Voltage (volts)	$V_{g_2(max)}$	250
Peak Screen Voltage—		
Pulse Negative* (volts)	$V_{g_2(pk)max}$	2000
Heater to Cathode Voltage (volts rms)	$V_{h-k(max)\ rms}$	200§
Grid 1 to Cathode		
Circuit Resistance (MΩ)	$R_{g_1-k(max)}$	1

* The pulse ratings are for Television Line Scan where the applied voltage pulse does not exceed 15% of one scanning cycle or 15 microseconds duration.

† The absolute rating of 8.5 kV must not be exceeded.

§ Measured with respect to the higher potential heater pin.

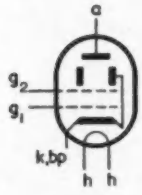
Inter-Electrode Capacitances (pF)

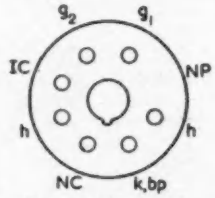
Grid 1 to Earth	C_{in}	20
Anode to Earth	C_{out}	10
Anode to Grid 1	C_{a-g_1}	0.3

Maximum Dimensions (mm)

Overall Length 113 Diameter 32 Seated Height 99

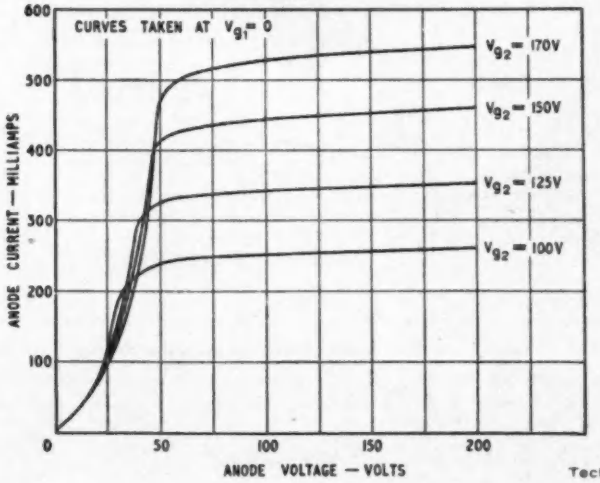
Base: International Octal (I07) **Top Cap:** CT1—Anode.



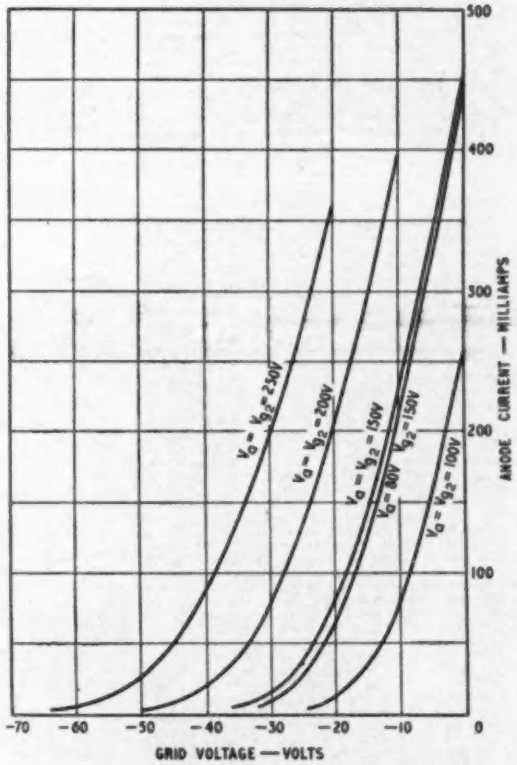


View of free end

Tentative characteristic curves of Ediswan Mazda Valve Type 30P19



Tentative characteristic curves of Ediswan Mazda Valve Type 30P19



EDISWAN
MAZDA

Associated Electrical Industries Ltd
Radio and Electronic Components Division
Technical Service Department, 155 Charing Cross Road, London, W.C.2
Tel: GERrard 8660. Telegrams: Sieswan, Westcent, London
CRC 15/84

EDUCATIONAL

CITY AND GUILDS (Electrical, etc.) on "NO PASS—NO FEE" terms. Over 95 per cent successes. For details of modern courses in all branches of Electrical Engineering, Applied Electronics, Automation, etc., send for our 148-page handbook —FREE and post free. B.I.E.T. (Dept. 337c), 29 Wright's Lane, London, W.8. W 316

LEARN RADIO AND ELECTRONICS the New Practical Way! Very latest system of experimenting with and building radio apparatus—'as you learn'. Free Brochure from Dept. EF10, Radiostructor, 40 Russell Street, Reading, Berks. W 353

LOUGHBOROUGH COLLEGE OF TECHNOLOGY, Leicestershire. Short course in instrumentation. A short course on Instrumentation for Control Engineering will be held from the 5th to the 25th April, 1961. The course gives an introduction to three of the main topics within Instrumentation, namely, Basic Measuring Principles, Control Theory, and Analogue Computation. Fees: 55 guineas inclusive of full residence; 30 guineas tuition fees only. Further particulars may be obtained from the Academic Registrar. W 5067

LOUGHBOROUGH COLLEGE OF TECHNOLOGY. Short Course on Instrumentation. A short course on Instrumentation for Control Engineering has been organized to take place from 5 to 25 April, 1961. The course aims at introducing three of the main topics within Instrumentation, namely, Basic measuring principles, Control Theory, and Analogue Computation. Fees: 55 guineas inclusive of full residence; 30 guineas, tuition fees only. Further particulars may be obtained from H. Buckingham, Esq., M.Sc., Ph.D., A.M.I.E.E., Head of the Department of Electrical Engineering, College of Technology, Loughborough, Leicestershire. W 5050

THE COLLEGE OF AERONAUTICS Two-Year Diploma Course 1961-1963. Applicaionts are invited from suitably qualified men and women who wish to enrol for the Two-Year Diploma Course which begins in October 1961. This post-graduate course in Aeronautical Science and Engineering is intended primarily for University Graduates in Engineering, Science or Mathematics. Technical College students and others who possess a Higher National Certificate, Diploma or equivalent qualification and attain the required entrance examination standard may also be accepted. The curriculum includes the subjects of Aerodynamics, Aircraft Design, Electrical and Control Engineering, Materials, Production and Industrial Administration and Aircraft Propulsion in all of which subjects a major specialisation may be taken. Lectures and laboratories in Mathematics and Flight are obligatory for all students. All applications will be considered by the Board of Entry which may call candidates to attend at the College for written Entrance Examination in Engineering, Physics, Mechanics, and Mathematics, to be held on Monday, 27th March, 1961. Exemption from this examination will normally only be given to candidates possessing 1st or 2nd Class Honours Degrees in Science or Engineering, or reading for Honours Degrees. The Board may also require attendance for personal interview at a later date. Candidates who possess Bachelors Degrees with 1st and 2nd Class Honours in Aeronautics, and also in Science or Engineering if they have adequate post-graduate experience, may at the discretion of the Board of Entry be accepted for entry to the second year of the course and qualify for the Diploma (D.C.Ae.). Further information about the course and forms of application, which must be completed and returned not later than Saturday, 4th March, 1961, may be obtained from The Warden, The College of Aeronautics, Cranfield, Bletchley, Bucks. W 5031

TV. AND RADIO—A.M.Brit.I.R.E., City & Guilds, R.T.E.B. Certificate, etc., on "NO PASS—NO FEE" terms. Over 95 per cent successes. For details of Examination and Home Training Courses (including practical apparatus) in all branches of Radio, T.V. and Electronics, write for 148-page handbook—Free. B.I.E.T. (Dept. 337H), 29 Wright's Lane, London, W.8. W 187

SERVICE

ELECTRONIC DEVELOPMENT UNDERTAKEN with manufacture up to medium production quantities. Specialists in audio practice, including competitive installation of equipment systems in the London area. Tansley Howard Limited, 95 Kensal Road, W.10 (LAD. 7195). W 2013

ENVIRONMENT CABINETS. Why use antiquated methods to obtain Low Temperatures when they can be obtained by the flick of a switch. Used for Metal Treatment, Research, Testing, Storage and Preservation. Will Lec Cabinet Temperature ranges from Plus 100 C to Minus 100 C cover your requirement ? Write for further details to—Low Temperature Division, Lec Refrigeration Limited, Bognor Regis, Sussex. W 5029

EXTRA PRODUCTION FACILITIES: Skilled workers + floor space + expert supervision = extra production facilities for you. See page 190. W 355

METALWORK. All types cabinets, chassis, racks, etc., to your own specifications. Philpott's Metalworks Ltd., Chapman Street, Loughborough. W 341

TRANSFORMERS DESIGNED AND MANUFACTURED Prototypes or batch productions of all types up to 3 KVA. Prompt delivery. Suppliers to BBC ITA., Universities and leading Industrial Concerns. Est. 1922. Phone: SHI: 2483. Forrest Transformers Ltd., Shirley, Solihull, Warwickshire. Telephone SHIrley 2483. W 350

TRANSLATIONS — TECHNICAL AND COMMERCIAL from: French, German, Dutch, into English. P. J. Arthern, 34 Oxford Road, Carshalton, Surrey. W 2012

CAPACITY AVAILABLE

CABLEFORMS AND WIRING. Lexor Electronics Limited have quantity capacity for all types of cableforms, looms, harnesses and equipment wiring. All inquiries to Allesley Old Road, Coventry. W 346

DON'T FORGET Precision Units Ltd., Seacrest Works, Church Road, Parkstone (1664) Dorset for Machine Engraved labels in plastic and metal. Keen prices. Reliable delivery. First Class productions. W 4024

ELECTRONIC ASSEMBLY & WIRING capacity available backed by full machine shop facilities. D.E.I. approved. G. H. Garland & Company Limited, 101-105, Nibthwaite Road, Harrow, Middlesex. Harrow 3536. W 4025

PRODUCTION CAPACITY. Lexor Electronics Limited have quantity production capacity available for electronic equipment and microwave assemblies. All inquiries to Allesley Old Road, Coventry. W 345

FOR SALE

ELECTRONIC ENGINEERING. January, 1948 to December, 1960. Complete and unblemished. First 9 volumes professionally bound in red cloth with gold lettering. Remaining 4 volumes complete with indexes but awaiting binding. Carefully packed and forwarded carriage paid to any address in G.B. for £15. Seville, Oakley, Waterfoot, Rossendale, Lancs. W 2009

LARGE STOCK of various surplus, electrical insulating materials in sheet, strip, tube, bar and rod form, plus a big quantity of 12 in. by 8 in. pieces of Paxolin sheet from $\frac{1}{8}$ in. up to $\frac{1}{2}$ in. thick; also large quantity of light, screened, cable in various sizes. Woodfield & Turner, Ltd., Burnley (Tel. 78134). W 5018

LENSES simple double Convex glass 17 mm dia. 24 mm focus approx. Ideal for Control Instruments and experimental work. 10/- per doz post free. P. Leighton, 2 Greenacre Road, Woolton, Liverpool. W 2014

FOR SALE: One Semi-Automatic Temperature Coefficient of Capacitance Test Apparatus Mark II. Designed by Signals Research Laboratory for high speed testing of capacitors. Full details and reduced price from L. Solloman Ltd., Beaufort Street, Manchester, 3. Telephone: BLA 4571. W 5032

50,000 PRECISION INSTRUMENT GEARS of all types from stock. (Now including spiral bevels.) Write for fully comprehensive catalogue. The Davall Gear Company Limited, Potters Bar, Middlesex (Telephone No. Potters Bar 2382). W 357

AGENCIES

AMERICA: YOUR MAN THERE. Can we advise you on sales prospects in the U.S., locate American Representatives, suggest new products for manufacture in your own plant, find an American licensee for your invention, or be useful in some other consultative capacity? Although electronics specialists, we would be happy to discuss assignments in other industrial fields. Ellis & Froud, P.O. Box 549, Times Square Station, New York 36, N.Y. W 5046

Variac

Regd. Trademark

WITH Duratrak*

This 3-gang assembly, Type 50-BMG3, will control 22·5 kVA, 3-phase or single-phase according to connection. Larger assemblies can be made.

THE MOST USEFUL DEVICE KNOWN FOR THE CONTROL OF AC VOLTAGE

VARIAC is the original continuously-adjustable auto-transformer, providing a smoothly variable output from zero to line voltage and above.

VARIACS are available in a very wide range of models from small units for laboratory and instrument use to large ganged assemblies for three-phase power.

VARIACS are available open or covered, as single units or ganged assemblies, for manual operation or motor-driven.

The range includes portable, metalclad and oil-immersed models, dual-output types, high-frequency types and many 'specials'.
Write for complete information.

This small Variac, Type V-5HMTF, provides an output of 0-270 V, 2 A. from 240 V 50 c/s mains. A still smaller model, Type V-3H is rated at 1 A.

* Duratrak ?

Duratrak (Regd. Trademark) — a patented* feature exclusive to Variac — is a special plated contact surface giving longer life, increased overload and surge capacity and maximum economy in maintenance. Duratrak is now standard on all models except Series 50.

*U.K. Pat. No. 693406

ONLY VARIAC HAS DURATRAK

Claude Lyons Ltd.

Valley Works · Hoddesdon . Herts · Tel: Hoddesdon 4541-6

and 76 Old Hall Street · Liverpool 3 · Tel: CENtral 4641-2

CL59/1B

CROSFIELD
LONDON ENGLAND

THE LEADING ELECTRONICS COMPANY IN THE GRAPHIC ARTS

ELECTRONICS DESIGN ENGINEER

PHYSICIST–ELECTRONICS ENGINEER

to work on a very interesting series of new projects where original thought and initiative are required.

The engineers will be required to take considerable responsibility and to follow a project through from the design stages to production.

An attractive high starting salary will be paid.

Minimum qualifications—Degree or H.N.C. Electronics with Industrial design experience.

The company under progressive management is rapidly expanding and the prospects of promotion are excellent.

Please apply in confidence to: **R. W. Franklin, Chief Research Engineer, J. F. CROSFIELD LTD., 2 Elthorne Road, London, N.19**

ATOMIC ENERGY RESEARCH ESTABLISHMENT HARWELL

have

Vacancies for

ELECTRONIC MECHANICS

ELECTRICIANS AND ELECTRICAL FITTERS

ELECTRO/MECHANICAL INSTRUMENT MECHANICS

The successful applicants will be those with good training and experience and who are willing to train for a varied and interesting range of experimental work.

Several of these vacancies are with the National Institute for Research in Nuclear Science and the new establishment being built nearby at Culham.

- ★ Superannuation and sick pay schemes
- ★ Assisted transport scheme
- ★ Further Education facilities
- ★ Housing provided for married men living outside the Harwell transport area, or assistance given with house purchase.

Please send for explanatory booklet and application forms to:

Industrial Recruitment Officer, A.E.R.E, Harwell, Didcot, Berks.

SECTION LEADER

Required to take charge of Process Control Section, including Nucleonic and general Electronic Instrumentation projects.

This is a senior position demanding drive, initiative and enthusiasm for development work.

The position carries a substantial salary, 3 weeks holiday and a pension scheme.

Preliminary interviews can be arranged for any time, including week-ends.

APPLY TO CHIEF ENGINEER,

stating experience qualifications, age and other relevant details.

BURNDEPT LIMITED

West Street, Erith, Kent.

ELECTRONICS ENGINEER

There is a continuous demand for test equipment caused through the increasing complexity of modern valves. We require an experienced electronics engineer to design such test equipment.

Experience of pulse circuits and a sound fundamental knowledge of oscilloscopes is essential.

Preferably applicants should possess a degree in electrical engineering or physics or equivalent qualifications and be within the age range 25 to 40.

Salary will take into account experience, qualifications and age.

Send brief resume of experience, qualifications etc. to:—

Group Personnel Services,

THE ENGLISH ELECTRIC COMPANY LTD.

English Electric House, Strand, London, W.C.2

quoting ref. EE1590C.

JUNIOR ENGINEERS AND TECHNICAL ASSISTANTS

Mullard

"Mullard" is the Trade Mark of Mullard Ltd.

FURTHER VACANCIES EXIST IN PROJECT TEAMS WORKING ON THE DEVELOPMENT AND PRODUCTION OF TRANSISTOR CIRCUITS FOR COMPUTER STORAGE SYSTEMS.

These vacancies will suit young men ambitious to gain experience in an expanding field of electronics.

Applications will be considered from men holding the Ordinary or Higher National Certificates or their equivalent, or having practical experience in electronics—particularly transistor circuitry.

The posts carry good salaries, excellent conditions of employment and first class prospects of advancement.

Write in confidence to: THE PERSONNEL OFFICER,

THE MULLARD RADIO VALVE CO. LTD.,

New Road, Mitcham Junction, Surrey.

Quoting Reference PC/EC/TA

BUSH

RADIO LIMITED

opportunities for engineers

TRANSISTORS • FREQUENCY MODULATION • VHF AND UHF TUNERS
REMOTE CONTROL • MINIATURISATION • PRINTED CIRCUIT TECHNIQUES
RADIO CIRCUIT DESIGN • PUSH BUTTON TUNERS • STEREOPHONIC
REPRODUCTION • TAPE RECORDERS • EXPORT RADIO TROPICALISATION
EXPORT TELEVISION • 625 LINE TELEVISION • COLOUR TELEVISION
TRANSISTORISED TEST GEAR • PATTERN GENERATORS

RECENT extensions to the Development Laboratories at Chiswick, Kew and Plymouth have created a number of attractive opportunities for keen *practical* Engineers of high calibre to join the very successful teams of Bush Radio specialists working in the varied fields set out above. Engineers of all grades are required for interesting and stimulating design and development work on Radio, Television, Tape Recorders, Radio Gramophones for the Home and Export markets.

The intricate test gear needed for manufacturing these products is now entering a most interesting phase of design and embraces a wide range of new techniques and materials affording exciting opportunities for the expression of engineering ability and the exercise of technical knowledge, resource and ingenuity.

SENIOR ENGINEERS (£1,250—£1,750)*

Experience and achievement in practical development work. Ability to lead and accept responsibility for group of engineers if necessary. These positions would appeal to men whose opportunities for advancement are at present restricted but who possess the ability and drive to undertake technical leadership in the future.

DEVELOPMENT ENGINEERS (£1,000—£1,250)*

Must have sound, up-to-date knowledge of radio or television circuit practice. Thorough familiarity with radio measurements and all classes of electronic measuring instruments. At least one year's practical work on circuit or test gear development essential.

TECHNICAL ASSISTANTS (£800—£1,000)*

Need keen interest in Radio or Television. HNC Standard and practical experience of radio or electronic measurements essential. Test and Service Engineers with good basic knowledge of Radio and Television principles and at least 3 years' practical experience with a variety of receivers would be considered provided they can show aptitude for design work.

**Salaries are not on a fixed scale, but will be the subject of negotiation and will be regularly reviewed. Rapid financial promotion will be possible for applicants capable of supervising a design from start to finish.*

SENIOR AND INTERMEDIATE DRAUGHTSMEN (£800—£1,200)

Experience in radio, television or electronic instruments. An interesting range of projects utilising the latest materials and techniques is in progress.

EXPERIENCED MODEL SHOP WORKERS

Model makers, instrument makers and sheet metal workers for work in the Model shops in liaison with the Development Laboratories.

Please write or telephone the **Personnel Manager, Bush Radio Limited, Power Road, Chiswick, London W.4.** (CHIswick 6491/9) for standard application form. Or, if you prefer, send an informal note to the Chief Engineer, covering your age, experience and qualifications and indicating location preferred (Chiswick, Kew, Plymouth) and initial salary.

ELLIOTT BROTHERS (LONDON) LIMITED

and

ASSOCIATED AUTOMATION LIMITED

(Members of the Elliott-Automation Group of Companies)

require a number of

DIVISIONAL CONTROLLERS

at their establishments at Borehamwood, Lewisham, Rochester and Willesden

The Divisions within these Companies are so organised as to exercise the greatest possible initiative and responsibility for their own development, production, sales and profitability.

DIVISIONAL CONTROLLERS are now being appointed, from existing staff and from newcomers, who will be responsible to their respective Divisional Managers for the continuous and constructive review and control of all aspects of their Division's activities which bear specifically upon its profitability.

DIVISIONAL CONTROLLERS should have experience of some branch of financial control in industry; and practical experience of development and production in the light engineering, electronics or associated fields. Candidates will however be considered whose career has been concerned with one of these activities, provided they have some familiarity with the other. The appointment will indeed be of particular interest to men who wish to broaden their managerial experience by working in a vital sector of industrial management within a rapidly expanding group of companies.

DIVISIONAL CONTROLLERS will not be responsible for accountancy as such, but applications from accountants who have the general qualifications described will be welcomed.

The Divisions within the two Companies concerned vary considerably in size and turnover. Salaries will be appropriate to the scale of operations in each Division. There are no specific age limits for these appointments.

Please send all information considered appropriate, in confidence, to:

Chief Personnel Executive,

Elliott Brothers (London) Limited,

70 Dudden Hill Lane, London, N.W.10

Central Electricity Generating Board

RESEARCH Laboratories, Leatherhead

DRAUGHTSMEN

Applications are invited for appointments as DRAUGHTSMEN (Electrical and Electronics) in the Drawing Office at the Research Laboratories, Leatherhead, Surrey.

The work entails the preparation from circuit diagrams of diagrammatic and working chassis layouts and wiring diagrams for prototype electronic and light electrical equipment. Familiarity with Interservice Standards and Specifications for electronic equipment would be an advantage.

Previous laboratory experience is not essential but an important factor is adaptability.

● ***Applications stating age, qualifications, experience, present position and salary, to the Appointments Officer, 24/30 Holborn, London E.C.1. Envelopes should be marked "Confidential Ref. EE/9."***

SALES/APPLICATIONS ENGINEER

To meet an expansion programme in the Instrument Division, an experienced Sales/Applications Engineer, with good technical qualifications is required.

Candidates must be in possession of a thorough grounding in Electronics and Instrumentation and, in addition to handling the sale of the Company's unique range of standard electronic products, must be capable of interpreting customer's specific requirements to a design team.

Customer liaison is required up to commissioning of process control systems, special purpose digital and analogue computers and instrumentation equipment.

This is a Senior staff appointment with Pension Scheme, and a Company car is provided.

Applicants should write to:

Assistant Managing Director,

NEWMAN INDUSTRIES LIMITED,

YATE, BRISTOL.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

PRODUCTION GROUP

INSTRUMENT MECHANICS

Windscale and Calder Works, and Chapelcross Works require experienced men with knowledge of electronic equipment and/or industrial instrumentation for fault diagnosis, repair and calibration of a wide range of instruments used in nuclear reactors, radiation laboratories and chemical plant. This interesting work involves the maintenance of instruments using pulse techniques, wide band low noise amplifiers, pulse amplitude analysers, counting circuits, television, and industrial instruments used for the measurement of pressure, temperature and flow.

Men with Services, Industrial or Commercial background of radar, radio, television, industrial or aircraft instruments are invited to write for further information. Training Courses in Specialised Techniques are provided for successful applicants having suitable instrumentation background. Married men living beyond daily travelling distance will be eligible for housing. A lodging allowance is payable whilst waiting for housing. Working conditions and promotion. prospects are good.

Applications to:—

Works Labour Manager, Windscale and Calder Works, Sellafield, Seascale, Cumberland.

or

Works Labour Manager, Chapelcross Works, Annan, Dumfriesshire, Scotland.

COMPUTER ENGINEER

BP has a vacancy for a Computer Engineer at its Head Office in the City of London, to join a small team of Engineers working on the maintenance of a large scale Ferranti MERCURY and CONVERTER installation. He will be expected to co-operate with a group of programmers working on a wide range of applications. Sound knowledge of practical electronics is essential but training in computer techniques would be given when necessary. Salary according to age, qualifications and experience. Non-contributory Pension Fund. Housing Scheme. Removal expenses and settling-in allowance payable in certain cases. Luncheon Club.

Write giving full details, quoting reference H.5158B, to Box 6492 c/o Hanway House, Clark's Place E.C.2

ADVANCED ELECTRONIC DEVELOPMENT

In view of the increasing demand for telecommunication equipment at home and abroad and the compelling need for progressive development in electronic techniques, this Company, the largest of its kind in the Commonwealth, requires the following additional technical staff:

LOGIC DESIGN & ELECTRONIC CIRCUIT ENGINEERS

for advanced development on electronic telecommunication systems. Applicants should hold a University degree or equivalent qualification and have several years experience of digital work.

TRANSMISSION ENGINEER

Applicants should hold a University degree or equivalent qualification and have several years experience of transmission circuit design. Experience of pulse transmission would be an added advantage.

APPARATUS ENGINEERS

for design of telecommunication apparatus and components Applicants should hold a University degree in Electrical or Mechanical Engineering or equivalent qualification.

ELECTRO-ACOUSTIC ENGINEERS

for design and testing of electro-acoustic apparatus for telecommunication work. Applicants should hold a University degree in Physics or Electrical Engineering or equivalent qualification. Knowledge of servo-mechanisms would be an advantage.

EQUIPMENT ENGINEERS

for preparation of technical specifications for production and installation of automatic telephone exchanges. Applicants should have telecommunication of light current engineering experience with H.N.C. or equivalent qualification.

Salaries offered will be progressive and in line with qualifications and experience. Comprehensive benefit schemes are in operation.

Write in confidence to the Personnel Manager, Standard Telephones and Cables Limited, Oakleigh Road, New Southgate, N.11, or telephone Enterprise 1234.

Interviews will be arranged at the above address or at Connaught House, Aldwych, W.C.2.

Standard Telephones and Cables Limited

Hawker Siddeley Aviation LIMITED

The DIGITAL COMPUTER GROUP

at the

A. V. ROE CHERTSEY RESEARCH & DEVELOPMENT LABORATORIES

which has successfully developed several Digital Differential Analysers has vacancies for:

MATHEMATICIANS

and

SYSTEMS DESIGNERS

as part of an expansion programme.

The Laboratories are situated in a pleasant part of West Surrey with ready access to London and the South Coast. Staff are encouraged to take as much responsibility for their work as possible and working conditions are congenial.

Applicants should have a degree in mathematics for the Mathematician vacancies. A degree in mathematics and/or Physics, or several years' experience of systems designs are required for the Systems Designer vacancies.

Apply—

A. V. ROE & CO. LTD.,

Chertsey Research and Development Group, Hanworth Lane, Chertsey, Surrey.

ARMSTRONG WHITWORTH EQUIPMENT

HUCCLECOTE, GLOUCESTER

require

SENIOR DESIGN ENGINEERS

Vacancies exist in an expanding organisation for engineers to fill senior positions in the design organisation. These are monthly staff appointments and only a limited number of vacancies exist.

Applications are invited from qualified engineers with experience in either Electronics, Electromagnetic or Hydraulic fields for work on a wide range of industrial and military control systems and their associated components.

Apply in writing to the

Resident Manager,

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD.,

Armstrong Whitworth Equipment, Hucclecote, Gloucester.

Telephone; Gloucester 66781.

SIMLAC

We have developed a new high-accuracy analogue computor to meet the requirements of the Atomic Energy and Chemical Engineering industries.

SENIOR ELECTRONIC DEVELOPMENT ENGINEERS

are needed to assist in the development of special electronic equipment to expand further the facilities of this computing machine. This is interesting and original work to be performed in modern well equipped laboratories.

If you have a degree in electronic engineering, or the equivalent, and at least two years laboratory experience of electronic equipment development, we shall be pleased to discuss with you an appointment to our Staff.

The Company operates a Superannuation Scheme with which is associated Life Insurance.

Assistance with housing and with removal expenses is available to married men from Great Britain.

Application should be made to the:—

Staff Appointments Officer,

SHORT BROTHERS & HARLAND LIMITED

P.O. Box 241,

Belfast, 3

Quoting: S.A. 658

ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL

requires an

ELECTRONICS TECHNICIAN

preferably with experience of pulse or nuclear instrumentation.

To be responsible for system fault diagnosis and repair of nuclear measuring, data collection and processing systems.

The establishment's experimental research work relies very much upon these systems which include:

PARTICLE DETECTION . ANALOGUE/DIGITAL CONVERSION
INFORMATION STORAGE . DATA PROCESSING AND DISPLAY

The work offers scope for initiative and includes installation of systems functional tests, calibration, servicing and maintenance and possibly staff supervision.

STARTING SALARY: According to experience within the following range. £1015-£1160 p.a.

Applicants should have served a recognised apprenticeship or have had equivalent training, and have a wide experience in Electronics. H.N.C. or equivalent an advantage.

Housing and superannuation schemes.

Send POST CARD for details to Personnel Manager (1866/42), U.K.A.E.A., A.E.R.E. Harwell, Didcot, Berks.

WESTLAND AIRCRAFT LTD.
SAUNDERS-ROE DIVISION

have vacancies for

ENGINEERS

to work on the trials and further development of "Black Knight" at High Down, Isle of Wight, and in Australia.

Applicants, who should have experience in one of the following:—

Control	**Guidance**
Data Reduction	**Instrumentation**
Ground Electrics	**Telemetry**
Ground Measurements	**Trials**

Mechanical Engineering

or in an allied field, together with enthusiasm and initiative, should forward details of their careers to date to:—

The Personnel Officer (EE/81)
Westland Aircraft Limited
Saunders-Roe Division
East Cowes, I.W.

G.E.C.

Progressive Senior Appointments

for

ELECTRONIC ENGINEERS

A number of vacancies for experienced circuit design Engineers have been created as a result of the continued expansion of these laboratories. The positions offer immediate technical and administrative responsibility and are expected ultimately to lead to project leader status for men of ability and initiative.

The vacancies will be of particular interest to engineers with experience of the application of semi-conductors in fields ranging from

TRANSISTORISED LOGIC AND DATA PROCESSING CIRCUITS

for military and industrial applications to

HIGH POWER STATIC INVERTERS

Candidates, aged at least 25 years, should hold a University degree, H.N.C., or an equivalent qualification and should have had at least 3 years practical experience in industry.

Salaries compare very favourably with those prevailing in the industry and are subject to annual review.

Applications should be made in writing to;—

THE CHIEF ENGINEER
THE GENERAL ELECTRIC COMPANY LIMITED
Electronic Division Laboratories
BROOK GREEN. HAMMERSMITH, LONDON, W.6.

PLESSEY NUCLEONICS

are extending their Electronics Laboratories at Northampton

The Company is engaged in the development of an interesting variety of nuclear electronic equipment, employing mainly transistor circuits.

Positions are available for Senior and Junior Circuit Engineers also for an Instrument Engineer with experience in light current electrical systems and servo control.

Write in confidence for further details to:—

Personnel Manager,

PLESSEY NUCLEONICS LIMITED,
Weedon Road,
Northampton.

AEI

Associated Electrical Industries Limited
Instrumentation Division

DRAUGHTSMEN

Associated Electrical Industries Limited have vacancies for Experienced DRAUGHTSMEN in their Scientific Apparatus Drawing Office, at Manchester, for work on Electronic Apparatus. Applicants should be able to prepare wiring diagrams and finished manufacturing drawings for equipment from schematic drawings. The work is interesting and involves all types of analytical instruments, but will mainly be concerned with Electron Microscopes and Mass Spectrometers. The department is expanding and there will be progressive opportunities for the right men.

Please write for Applications Form quoting reference Z.17 to:—

Personnel Manager,
Associated Electrical Industries (Manchester) Ltd.,
Trafford Park, Manchester, 17.

ELLIOTT

The following staff are required by INERTIAL NAVIGATION division at Borehamwood

SENIOR ENGINEERS (2)

Candidates must be University Graduates with not less than three years' experience in servo-electronics and light electro-mechanical engineering. Trials experience would be an advantage but not essential.

JUNIOR ENGINEERS
TECHNICAL ASSISTANTS

Candidates for these posts, of which there are several, must have a minimum qualification of H.N.C. with at least one year's experience in servo-electronics and light electro-mechanical engineering. Trials experience would be an advantage but not essential.

FLIGHT TRIALS ANALYSTS (2)

Candidates should be University Graduates and experience in Flight Analysis would be an advantage.

Appointments to all above vacancies will be at the Company's Borehamwood establishment, but applicants must be prepared to spend long periods away from base, in the U.K. and possibly overseas. Appropriate salaries and allowances will be offered.

Please apply quoting reference No. 311 to Personnel Manager, Elliott Brothers (London) Limited, Elstree Way, Borehamwood, Herts.

TECHNICAL REPRESENTATIVE

The Technical Services Department of S. SMITH & SONS (ENGLAND) LTD., wish to appoint a Technical Services Representative for liaison work on aviation instrument equipment.

Practical experience and theoretical knowledge of aircraft instrument and electronic equipment is essential together with O.N.C. in electrical or mechanical engineering. Age under 30 for preference.

The person appointed will be required to travel in the United Kingdom and abroad.

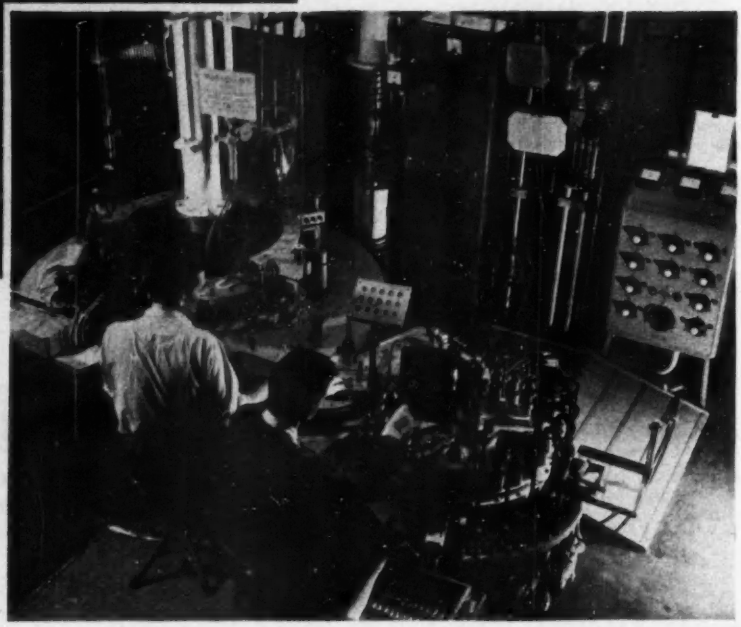
Applications will be treated in strict confidence and should be made in writing, quoting reference SM353, to:—

The Staff Manager,
S. SMITH & SONS (ENGLAND) LTD.
Cricklewood, London, N.W.2

or telephone GLAdstone 3333, Extension 132, for further information.

EE 30 269 *for further details*

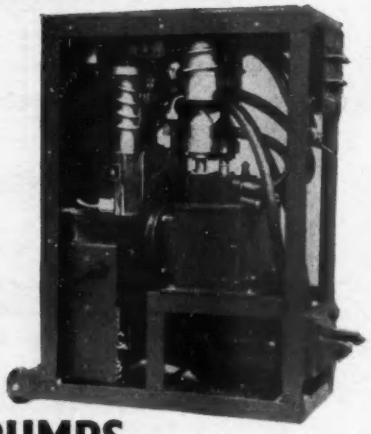
VALVES and VACUUM



TOP:
A battery of 1M2 mercury diffusion pumps on a rotary machine for sub-miniature valve assemblies. (Courtesy of Brimar Electronics Ltd.)

CENTRE:
Rotary pumping machine for receiving valves. A 9B3 vapour booster pump supplies the vacuum through an overhead manifold. (Courtesy of Mullard Ltd.)

BOTTOM:
One unit from a 32-head machine for miniature valves. This section incorporates two rotary and two diffusion pumps and is only 26 inches high.



"Speedivac" pumps are in use throughout the world for valve manufacture, whether the application demands the fitting of pumps to large machines for mass production or special pumping systems for large, powerful electronic devices such as magnetrons, klystrons etc. Some examples are shown here and we shall always be pleased to discuss the provision of suitable pumps and to build complete units to your specification.

"SPEEDIVAC" HIGH VACUUM PUMPS

EDWARDS HIGH VACUUM LTD	MANOR ROYAL	CRAWLEY Crawley 1600	SUSSEX	ENGLAND

INDEX TO ADVERTISERS

A

AEI—Birlec Ltd. 7
A.P.T. Electronic Industries Ltd. 43
Acbars Ltd. 164
Adcola Products Ltd. 168
Advance Components Ltd. 31, 79, 137
Airmec Ltd. 115
Allied Electronics Ltd. 170
Alma Components Ltd. 3
Ampex International 133, 135
Anders Electronics Ltd. 178
Ardente Acoustic Laboratories Ltd. 160
Armstrong Whitworth Equipment 40
Ashburton Resistance Co. Ltd. 198
Asmidar Plastic Moulding Machines Ltd. .. 191
Associated Electrical Industries Ltd. .. ..
12, 75, 106, 142, 159, 211, 219
Associated Transistors Ltd. 153
Austinlite (Stone-Chance Ltd.) 97
Aveley Electric Ltd. 64

B

B & K Laboratories Ltd. 5
B & R Relays Ltd. 99
BX Plastics Ltd. 143
Barr & Stroud Ltd. 162
Belling & Lee Ltd. 101
Berry's Radio 198
Birch, H. A., & Co Ltd. 116
Birkbys Ltd. 54
Blackburn Electronics Ltd. 35, 47
Bolton, Thomas, & Sons Ltd. 3
Brandenburg Ltd. 72, 73
Bribond Ltd. 119
Brimar Ltd. 63
Britec Ltd. 160
British Driver-Harris Co. Ltd. 158
British Insulated Callender's Cables Ltd. .. 87
British Paints Ltd. 58
British Petroleum 217
Brown, N. C., Ltd. 196
Broxlea Products Ltd. 190
Brush Crystal Co. Ltd. 82
Bullers Ltd. 66
Burndept Ltd. 214
Bush Radio Ltd. 215

C

Cannon Electric International Inc. 45
Cayson Electrics Ltd. 166
Central Electricity Generating Board 216
Chapman & Hall Ltd. 113
Ciba (A.R.L.) Ltd. 53
Clarkes (Redditch) Ltd. 174
Cleaver-Hume Press Ltd. 114
Colvern Ltd. 178
Co-Ordinators Service (Engineering) Ltd. .. 180
Continental Connectors Ltd. 117
Contour Photocopying Ltd. 197
Cossor Instruments Ltd. Inset facing pages 16 & 17
Counting Instruments Ltd. 49
Crofts (Engineers) Ltd. 44
Crosfield, J. F., Ltd. 214

D

Datum Metal Products Ltd. 184
Davis, Jack (Relays) Ltd. 180
Dawe Instruments Ltd. 61
Decca Radar Ltd. 30
Denman Products Ltd. 103
Derritron Electronics Group 108
Dobbie McInnes Ltd. 192
Donovan Electrical Co. Ltd. 146
Dowding & Doll Ltd. 165

E

E.M.I. Electronics Ltd. Inset facing pages 64 & 65
Eddystone Radio (Stratton & Co. Ltd.) 124
Edwards High Vacuum Ltd. 220
Egen Electric Ltd. 164
Electro Methods Ltd. 171
Electronic Instruments Ltd. 33
Electronic Tubes Ltd. 4
Elgar Trading Ltd. 160
Elliott Brothers (London) Ltd. .. 189, 216, 219
Empire Rubber Co. Ltd. 152
Enalon Plastics Ltd. 182
English Electric Co. Ltd. 41, 148, 214
English Electric Valve Co. Ltd. 57
Ericsson Telephones Ltd. 10, 151
Erie Resistor Ltd. .. .. .. Cover iii
Evans, Frederick W., Ltd. 182
Evershed & Vignoles Ltd. 132

F

Farnell Instruments Ltd. 199
Ferranti Ltd. 6
Formica Ltd. 51
Fortiphone Ltd. 162
Fraser, Speller Transformers Ltd. 182

G

G.W.B. Furnaces Ltd. 192
Gardner, Henry, Ltd. 170
Gardners Radio Ltd. 59
General Electric Co. Ltd. 8, 141, 219
Goodmans Industries Ltd. 185
Graphite Products Ltd. 28
Griffiths, Gilbart, Lloyd & Co. Ltd. 196
Guest Keen & Nettlefolds Ltd. 113
Guyson Industrial Equipment Ltd. 166

H

Haddon, Thomas, & Stokes Ltd. 188
Harboro' Rubber Co. Ltd. 199
Harwin Engineers Ltd. 80
Hassett & Harper Ltd. 128
Hatfield Instruments Ltd. 176
Hedin Ltd. 202
Hewlett Packard S.A. Geneva 109
Hirst Electronics Ltd. 194
Hitachi Ltd. 120
Hivac Ltd. 85
Honeywell Controls Ltd. 125
Hughes International Ltd. 91

I

Ilford Ltd. 18
Imhof, Alfred, Ltd. 24
Imperial Chemical Industries Ltd. 177
Industrial & Commercial Finance Corpn. .. 221
Insuloid Manufacturing Co. Ltd. 168
International Computers & Tabulators Ltd. .. 111
International Rectifier Co. (Gt. Britain) Ltd. .. 126

J

Jobling, James A., & Co. Ltd. 78
Johnson Matthey & Co. Ltd. 123
Jones & Rooke (1948) Ltd. 46
Jones, Walter, & Co. (Engineers) Ltd. .. 29

K

Kasama Electronics Ltd. 102
Keyswitch Co. .. .. Cover iv

L

Langham Thompson, J., Ltd. 94, 95
Lewis Spring Co. Ltd. 209

MORE PERMANENT CAPITAL IS WHAT YOU NEED—

to finance new equipment, plant, machinery and buildings for your expansion and progress.

Capital for this purpose is provided both in the form of long-term loans and share capital by

ICFC

The booklet 'Capital for Business' will be sent on request

INDUSTRIAL & COMMERCIAL FINANCE CORPORATION LTD

HEAD OFFICE: 7 Drapers' Gardens, London EC2. National 8621/5

and branches in industrial centres

V9

EE 30 270 *for further details*

INDEX TO ADVERTISERS *(continued from previous page)*

Lenor Electronics Ltd. 196, 205
Linvar Ltd. 200
Livingston Laboratories Ltd. 60, 138
Londex Ltd. 186
London Electric Wire Co. Ltd. & Smiths Ltd. & Vactite Wire Co. Ltd. 174
Lucas, Joseph, Ltd. 84
Lyons, Claude, Ltd. 213

M

M.O. Valve Co. Ltd. 98
Marconi Instruments Ltd. 107
Markem Machine Agency 193
Marshall of Cambridge Electronic Ltd. .. 172
Measuring Instruments (Pullin) Ltd. 105
Metachacts Ltd. 188
Midland & Lowmoor Iron & Steel Co. Ltd. .. 110
Midland Silicones Ltd. 56, 86
Mills & Rockley Electronics Ltd. .. 150
Miltoid Sales Division (BX Plastics Ltd.) .. 164
Mond Nickel Co. Ltd. 96
Morawelon Engineering Ltd. 160
Muirhead & Co. Ltd. 14
Mullard Ltd. 19, 21, 23, 48, 89, 112, 122, 139, 163
Mullard Radio Valve Co. Ltd. 214
Multicore Solders Ltd. 191

N

N.G.N. Electrical Ltd. 184
N.S.F. Ltd. 140
Nagard Ltd. 17
Nash & Thompson Ltd. 144
Neoflex Ltd. 180
Newnes, George, Ltd. 186
Newport Instruments Ltd. 205
Newman Industries Ltd. 216
Newton Bros. (Derby) Ltd. 204
Nippon Electric Company Ltd. 70
Nuclear Enterprises (G.B.) Ltd. 206

O

Oliver Pell Control Ltd. 22, 34

P

Painton & Co. Ltd. 173
Panellit Ltd. 181
Panorama Radio Company 200
Parmeko Ltd. .. .. Cover i
Partridge Transformers Ltd. 174
Permanoid Ltd. 202
Phillips Control (Gt. Britain) Ltd. 196
Pitman, Sir Isaac, & Sons Ltd. 170
Plannair Ltd. 169
Plessey Co. Ltd. 16, 38, 83, 88, 219
Polypenco Ltd. 195
Preformations Ltd. 136
Pye, W. G., & Co. Ltd. 134

Q

Quartz Crystal Co. Ltd. 199

R

Radiometer 15
Radiospares Ltd. 42, 90
Rank Cintel Ltd. 52
Research & Control Instruments Ltd. .. 199
Rivlin Instruments Ltd. 9
Roband Electronics Ltd. 25, 26, 27
Recol Ltd. 20
Roe, A. V., & Co. Ltd. 218
Royce Electric Furnaces Ltd. 55

S

S. & D. Rivet Co. (Steels & Busks Ltd.) .. 205
Salford Electrical Instruments Ltd. .. 68, 201
Salter, George, & Co. Ltd. 74
Sanders, W. H. (Electronics) Ltd. 194
Sangamo Weston Ltd. 222
Saunders-Roe Ltd. 62
Savage Transformers Ltd. 175
Servo Consultants Ltd. 176
Servomex Controls Ltd. 156, 157
Sheffield Smelting Co. Ltd. 187
Short Brothers & Harland Ltd. 218
Sifam Electrical Instruments Co. Ltd. .. 183
Sivers Lab 203
Smith, S. & Sons Ltd. 219
Smiths Clocks & Watches Ltd. 135
Solartron Electronic Group Ltd. 39, 92, 93, 154, 155
Spencer, George, & Sons (Market Harboro') Ltd. 201
Standard Telephones & Cables Ltd. 65, 67, 69, 71, 127, 129, 131, 198, 217
Steatite & Porcelain Products Ltd. 167
Stewart Transformers Ltd. 200
Swindon Condenser Co. Ltd. 81

T

Talbot Tool Co. Ltd. 194
Taylor Electrical Instruments Ltd. 121
Telephone Mfg. Co. Ltd. 13, 118
Telequipment Ltd. 2
Terry, Herbert, & Sons Ltd. 179
Tessier, V., Ltd. 182
Texas Instruments Ltd. .. 145, 147, 149
Thermal Syndicate Ltd. 188
Thorn Electrical Industries Ltd. 104
Tokyo Shibaura Electric Co. Ltd. 32
Transradio Ltd. 76, 77
Trumeter Co. Ltd. 197

U

U.K.A.E.A. 214, 217, 218

V

Vactric (Control Equipment) Ltd. 161
Vacwell Engineering Co. Ltd. .. .. Cover ii
Veeder-Root Ltd. 203
Venner Accumulators Ltd. 50
Vero Precision Engineering Ltd. 100

W

Waycom Ltd. 150
Wayne-Kerr Laboratories Ltd. 130
Webber, R. A., Ltd. 197
Westland Aircraft Ltd. 218
Westool Ltd. 36, 37
Westrex Co. Ltd. 11
Whiteley Electrical Radio Co. Ltd. 209
Wiggin, Henry, & Co. Ltd. 114
Wilkinson, L. (Croydon) Ltd. 192
Winston Electronics Ltd. 204
Woodhill Engineering Co. Ltd. 206
Wright & Marvin Ltd. 200

Z

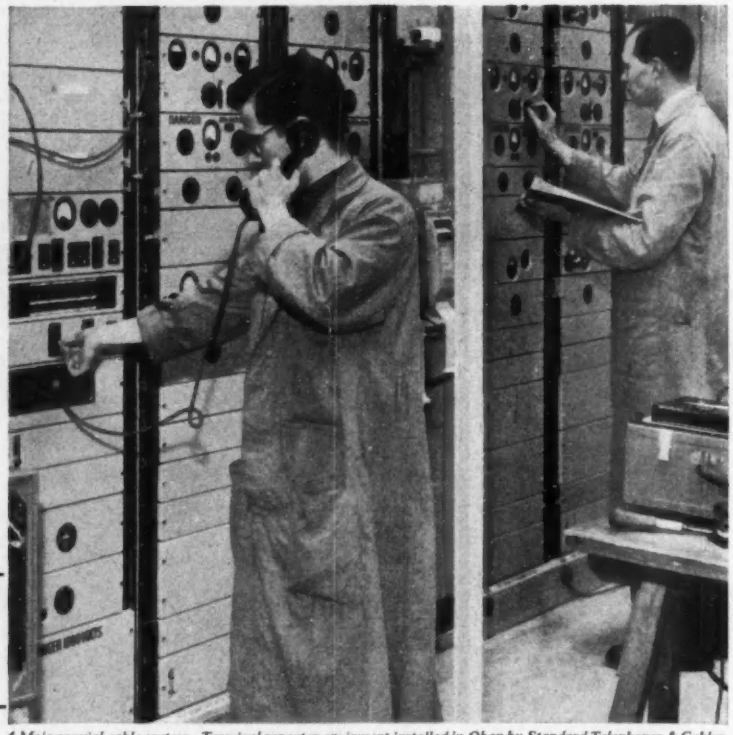
Zenith Electric Co. Ltd. 172

IT COSTS NO MORE TO BUY THE BEST

Specify WESTON on your equipment

The demand created by the high quality of Weston meters is such that production techniques can be employed which enable these outstanding instruments to be produced at competitive prices.

There can be no finer advertisement for your equipment than the name "Weston" on the meters installed



4 Mc/s coaxial cable system. Terminal repeater equipment installed in Oban by Standard Telephones & Cables Ltd — part of the transatlantic telephone link.

SANGAMO WESTON

SANGAMO WESTON LIMITED · ENFIELD · MIDDX

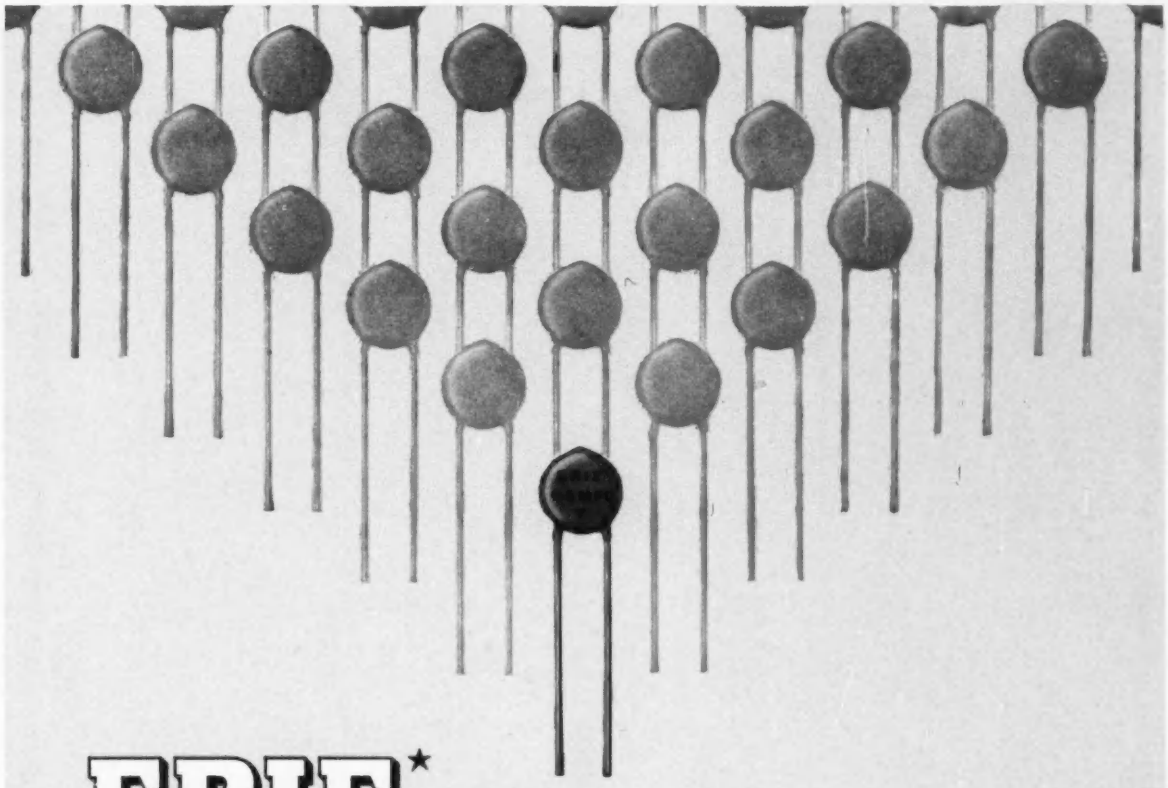
Tel: Enfield 3434 (6 lines) & 1242 (6 lines) Grams: Sanwest, Enfield

SW/102

EE 30 271 *for further details*

Printed in Great Britain by The Press at Coombelands, Ltd., Addlestone, Surrey, for the Proprietors, Morgan Brothers (Publishers), Ltd., 28, Essex Street, Strand W.C.2. Registered for Transmission by Canadian Magazine Post.

222/70



ERIE* Transcaps

Patent applied for

for all Transistor Circuits

SPECIFICATION

Diameter : 0.594 inches maximum

Thickness : 0.156 inches maximum

Capacitance : 0.5 mfd

Tolerance : −20% +50%

Working voltage : 3 volts d.c.

Power factor : Not greater than 5%, when measured at 1 kc/s, and less than 0.5 volts

Leakage resistance : Not less than 100,000 ohms, when measured at 3 volts

In line with the Erie policy of anticipating the component requirements of the future, the Erie Transcap capacitor is now added to our ever-increasing range of components for use with transistors.

Designed specifically as a small, reliable, high capacitance, low voltage, coupling, and by-pass capacitor, the Erie developed Transcap is manufactured entirely at our Great Yarmouth factory.

Style T, shown here in its actual physical size, is but a forerunner of the wide range, in differing values and voltages, which will ultimately emerge.

ERIE* RESISTOR LIMITED

1, HEDDON STREET, LONDON, W.1

Telephone: REGent 6432

FACTORIES

Great Yarmouth and Tunbridge Wells, England: Trenton, Ont., Canada: Erie, Pa., Holly Springs, Miss., and Hawthorne, Cal., U.S.A.

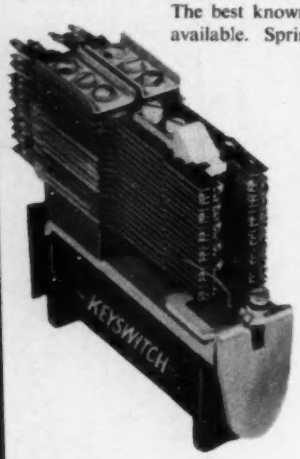
*Registered Trade Mark

Men in the Know

HAVE THE RIGHT CONTACTS

MAJOR TYPE 'BPO 3000'

The best known and most useful relay available. Spring sets allow from one make or break to 12 changeovers. For minute or heavy switching. Sensitivity down to 20 milliwatts. Adjustable for critical timing, fast or slow operation. Standard or Tropical finish. Special adaptations can be supplied.



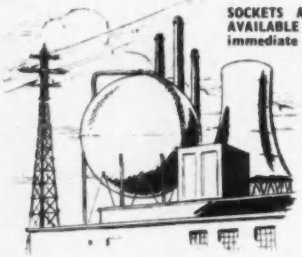
Transparent covers for above now available.

and now PLUG-IN 3000 Type Relays.

Plug-in facilities in addition to all the versatility and well-established, reliable features of the world's best known relays.

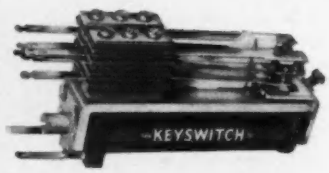
- ★ Positive contact between male and female pins.
- ★ Contacts: up to 18 light duty or 12 heavy duty.
- ★ Complete transistorized units.
- ★ AC or DC operation.
- ★ Transparent or metal cover.
- ★ Clip retains relay positively in any position.

SOCKETS AND FITTINGS ARE AVAILABLE FROM STOCK for immediate assembly of units.



PLUG-IN-TRANSISTORIZED UNIT

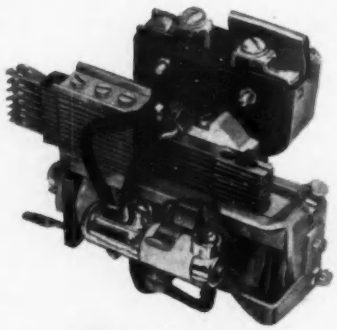
Operation AC or DC. Switching or Signal Current AC or DC. 5 to 500 micro-amps. Transfer switching current 10 amps. or 500v.



MINOR TYPE '600' (Fitted with double pole changeover for 250 volts 2 amps.)

Ideal for simple switching operations where lightness, compactness and economy are prime considerations. When fitted with contacts similar to those of the 'B.P.O. 3000' type it is faster in operation and release.

This relay incorporates 15 amp. Micro Switch; 5 amp. Mercury Switch and standard 0.3 to 8 amp. contacts.



Available free on request, unique calculator providing full relay specifications

KEYSWITCH RELAYS

Production Manager:

2 Irongate Wharf Road, Praed Street, London, W.2

Telephone: PADdington 2231

Extremely advantageous quotations can be offered for quantity orders. Contractors to Home and Overseas Governments and H.M. Crown Agents

RELAYS FOR ALL PURPOSES can be manufactured to customers' requirements for:—

AUTOMATION
COMPUTERS
BATCH COUNTING and PHOTO-ELECTRICS
TELEPHONY and INTERCOM SYSTEMS
AUTO-TIMING and AUTOMATIC SIGNALS
MOTOR and MACHINERY CONTROL
CURRENT and VOLTAGE REGULATION
Etc.